REPORT

OF THE

Indian Tariff Board

ON THE

GLASS INDUSTRY

CALCUTTA: GOVERNMENT OF INDIA
CENTRAL PUBLICATION BRANCH
1932

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Technical Adviser . . .	Mr. F. W. Hodkin, B.Sc., F.I.C.

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PRELIMINARY.

The enquiry into the glass industry was referred to the Board in the Government of India, Commerce Department's Resolution No. 458-T. (2), dated 20th October, 1931. The terms of the Resolution are as follows:—

> "The Government of India have received representations from certain glass manufacturers requesting that protection may be extended to the glass industry in India. In pursuance of paragraph 3 of the Resolution of the Government of India, Department of Commerce, No. 3748, dated the 10th July, 1923, they have decided to refer to the Tariff Board for examination these representations along with any others of a similar nature which may be brought to its notice.
>
> 2. In making its enquiry, the Tariff Board will be guided by the principles laid down in the Resolution adopted by the Legislative Assembly on February 16th, 1923, and will consider—
>
> (1) whether the conditions laid down in the Report of the Indian Fiscal Commission are satisfied in the case of the industry, and to what extent, if any, and in respect of what articles, or class or description of articles, protection should be afforded;
>
> (2) in what form and for what period protection, if any, should be given; and
>
> (3) how its recommendations, if any, will affect other industries.
>
> 3. Firms and persons interested who desire that their views should be considered by the Tariff Board should address their representations to the Secretary to the Board."

The Board issued a Press Communiqué, dated 20th October, 1931, calling upon all firms and persons interested in the enquiry to make written representations not later than 20th November, 1931. Mr. F. W. Hodkin, B.Sc., F.I.C., who was appointed by the Government of India, Technical Adviser to the Board, for the purpose of this enquiry, arrived on November 13th. On November 21st, the Board issued questionnaires for manufacturers and importers. Replies were received from factories and from manufacturing associations. Representations were also received from a large number of firms interested in the use of glass bottles and containers. We made a tour of inspection of glass factories beginning at the end of November, the programme being as follows:—

Nov. 23rd.—Visited Kandivli Glass Bangle Factory.

Nov. 25th.—Visited Paisa Fund Glass Works, Talegaon.

Nov. 26th.—Visited Ogale Glass Works, Ltd., Ogalewadi.

Dec. 1st.—Left Bombay.

Dec. 2nd—5th.—Arrived Agra. Visited Firozabad bangle factories.

Dec. 6th.—Visited Upper India Glass Works, Ambala.

Dec. 7th.—Visited United Provinces Glass Works, Ltd., Bahjoi.

Dec. 8th—10th.—Visited Allahabad Glass Works, Naini.

Dec. 11th.—Arrived Calcutta.

Dec. 14th.—Visited Bengal Glass Works, Ltd., and Mr. P. M. N. Mehta's Bangle Factory.

Dec. 15th.—Visited Calcutta Glass and Silicate Works, Ltd.

Dec. 22nd.—Visited Kumardhubi Fireclay and Silica Works (Messrs. Bird and Company, Ltd.).

Jan. 2nd.—Visited the Potteries, Jubbulpore (Messrs. Burn and Company, Ltd.).

While at Allahabad we invited Mr. J. L. Sathe, I.C.S., Director of Industries, United Provinces, and Dr. H. D. H. Drane, D.Sc., Principal of the Harcourt Butler Technological Institute, Cawnpore, to meet us, and we had the advantage of a discussion with them on matters affecting the industry. In Calcutta we took oral evidence from the Bengal Glass Works, the Calcutta Glass and Silicate Works and Mr. P. M. N. Mehta on the 17th and 19th December. The Board's office opened in Bombay on January 2nd, 1932, after the Christmas holidays. The following oral evidence was taken in Bombay:—

Jan 11th.—United Provinces Glass Works, Bahjoi.

Jan. 12th.—Allahabad Glass Works, Naini.

Jan. 13th.—Upper India Glass Works, Ambala.

Jan. 13th.—Mr. Meyer Nissim, Bombay.

Jan. 14th.—Ogale Glass Works, Ogalewadi.

Jan. 18th.—Kandivli Glass Bangle Factory.

Jan. 18th.—Paisa Fund Glass Works, Talegaon.

Jan. 19th.—Glass and Bangles Industrial Association, Firozabad.

We wish to express our appreciation of the courtesy and hospitality which was shewn us by the proprietors, managers and staff at all the factories we visited.

We desire also to acknowledge the services rendered by our Technical Adviser, Mr. F. W. Hodkin, whose co-operation has been of the greatest assistance to us in the elucidation of the technical and practical aspects of the glass industry in India. His accurate and detailed knowledge has greatly facilitated our investigation of the problems connected with this enquiry. In the inspection of factories, in the examination of witnesses and above all in the preparation of the materials on which our Report is based, his co-operation has proved invaluable. His close acquaintance with

the glass industry in other countries and his thorough grasp of the commercial as well as scientific questions involved in it have enabled us to appreciate the position of the Indian industry with greater accuracy and clearness than would have been possible otherwise. While for the actual findings and proposals contained in this Report we hold ourselves entirely responsible, both in the manner in which they are stated and explained and in the marshalling and interpretation of the evidence on which they are based we have benefited greatly by his clear perception and expert criticism and judgment and by the untiring energy which he has devoted to his work.

Report on the Glass Industry.

CHAPTER I.

The Present Position of the Glass Industry in India and its Methods of Production.

The past history of the glass industry in India

Dr. C. S. Fox of the Geological Survey of India in his "Notes on Glass Manufacture" published in 1922, observes that there is no evidence of the existence in India in early times of a great and flourishing glass industry. "The first Indian (Ceylon) references to glass are in the Mahavamsa, the chronicles of the Sinhalese Kings (B.C. 306), when glass mirrors were carried in processions. Crude glassware and ornaments of glass of about the early Christian era have been found in various parts of India, but there is no evidence for supposing that a flourishing industry existed in India at that time." He adds that though it is known that glass decorated with enamel was made in Delhi during the seventeenth century, the glass industry throughout its history in India appears never to have approached the proportions attained during the war years 1914—1918. Mr. (now Sir Alfred) Chatterton in his article on "The manufacture of glass in India" in the Indian Munitions Board Handbook regards it as certain "that in the sixteenth century there was an established industry which had not advanced beyond the stage of producing a very inferior material, utilised almost entirely for the manufacture of bangles and, to a very limited extent, for small bottles to hold perfumes and for flasks in which to store Ganges water". He also quotes Buchanan's reference to the art of glass making as practised at Muteodu, which he visited on a journey from Madras through Mysore at the beginning of the nineteenth century; "the glass maker's furnace here is rather better than that of Chenna-pattana; but still it is extremely crude. The manufacturers say that when the army of Lord Cornwallis left Seringapatam, they gathered with much pains a number of broken bottles which they found where he had encamped. These they thought a treasure; but, after having been at the expense of bringing the bottles to Muteodu, they found that their furnace was not sufficiently strong to liquify European glass. The bottles were then reduced to powder and mixed with alkali, but these materials produced only a useless white mass. Our glass, therefore, is considered by them as useless as our cast iron; for neither of these substances are in a state upon which their fires have any effect".

2. The manufacture of glass and glass articles on modern lines started in India in 1892. Between 1892 and 1900 five modern factories were established, two of which did not long survive. Of the other three, all of which were under European management, assisted by men trained in European glass works, and two of which were equipped with large modern furnaces and plant and were not stinted for capital, one worked from 1892 to 1899, another from 1898 to 1902 and the third from 1900 to 1908. A final attempt was made by Europeans in Madras in 1909; but this Company also ceased operation after three years' work and went into voluntary liquidation. The failure of all these concerns is ascribed by the Indian Industrial Commission (Appendix E) to the inadequate technological skill of the European experts, who were further handicapped by the demand for quick results before they had had time to acquaint themselves with local conditions, such as the influence of the climate and the potentialities of the local raw materials and labour.

Early experiments on modern lines.

3. In spite of these failures the industry appears to have had a special fascination for Indian enterprise; for between 1906 and 1913, 16 factories were established under Indian management, assisted sometimes by European trained glass workers who stayed on in the country after the earlier ventures had failed, and sometimes by Japanese working under the control of Indians who had been to Japan to learn the business. Unfortunately these undertakings do not seem to have profited by the experience of the earlier failures. In no case were such preliminary investigations carried out as are generally deemed essential before a new industry is started; and at the outbreak of the war in 1914 only three of the factories were in operation and not one of them was making a commercial profit. The outbreak of the war at once stopped the flow of imports from Germany and Austria. To supply the need thus created new factories came into existence; and it was estimated that in 1918 about twenty factories were at work, of which seven at Firozabad were engaged entirely in the manufacture of glass for bangles, and the others produced mainly lampware and to a less extent bottles and carboys. Under the stimulus of the demands of the Indian Munitions Board several factories had with some degree of success produced glass tubing, flasks, beakers and test tubes of non-resistant glass. The capital invested in glass works, apart from the bangle trade, was estimated at about Rs. 15 lakhs, and a very rough estimate valued the outturn of bangles at nearly Rs. 20 lakhs a year and that of other glassware at a similar amount. Other countries besides India had developed their glass making resources to meet the conditions and demands arising out of the war; and when these conditions were withdrawn, many of them were in a position to do a big export trade. Some countries erected new factories to meet the growing demands of the trade which they had established; in other countries, of which India was one, the serious competition from abroad forced the factories either to close down or to reduce their cost of production.

Developments before and during the war.

The present scope of the industry.

4. The struggle against competition with imported goods has continued till quite recently when the industry has received some assistance from the increase of the revenue duties from 15 to 20 per cent. in March 1931 and to 25 per cent. in September, and from the recent alterations in Japanese and European exchange. From various sources we have received information of the existence at present of fifty-nine factories, twenty-six of which are engaged entirely in the manufacture of bangles and one in the manufacture of false pearls. The Glass Manufacturers' Association, which does not concern itself with the bangle making part of the industry, has given us a list of twenty-two factories. A list supplied by the Director of Industries, Bombay, omits four of the factories mentioned by the Association, but includes fourteen additional factories, ten of which are bangle factories. The Firozabad Glass and Bangles Industrial Association mention twenty works engaged in the manufacture of bangles at Firozabad; they omit three mentioned by the Director of Industries, Bombay, but include fifteen works which are not in his list. Dr. Drane has given us a list of sixteen factories, other than bangle factories, which includes two factories in or near Bombay which have not been mentioned by the Bombay Director of Industries. Finally four manufacturers (one at Naini near Allahabad, one at Dacca, one maker of bangles in Calcutta and one maker of false pearls in Bombay) who are mentioned in none of these lists, have made their existence known to us either in person or by letter or by both methods. The distribution of the fifty-nine factories is shown in the following Table:—

TABLE I.

Province or State.	Glass Manufacturers Association.	Glass and Bangles Industrial Association, Firozabad (Bangle factories).	Director of Industries, Bombay.		Dr. Drane.		All sources.	
			Bangle factories.	Others.	Bangles.	Others.	Bangles and false Pearls.	Others.
Punjab	1	..	..	1	..	1	..	1
United Provinces	8	20	8	7	25*	4	23	11
Bengal	6	..	..	7	..	4	1	10
Bombay	4	..	2	4	..	5	3	6
Central Provinces	2	..	..	2	..	2	..	2
Bikanir	1	..	..	..	..	..	..	1
H. E. H. the Nizam's Dominions.	..	..	..	1	..	..	..	1
TOTAL	22	20	10	22	25	16	27	32

It is evident from the foregoing statement that there has been a considerable expansion of the glass industry in India in recent years.

* Furnaces, two or three of which may be in one factory.

Of the twenty factories represented by the Glass and Bangles Industrial Association, Firozabad, sixteen have been started since the year 1925. We have been informed that it was only then that the manufacturers learnt how to produce coloured glass of such a quality as to enable them to imitate the coloured and decorated bangles imported from Japan and Czechoslovakia; and the industry has in the last six years expanded rapidly in this direction. New factories have also been established for the manufacture of blownware, while in two of the older factories modern machinery, in one case for the manufacture of sheet glass and in the other case for the manufacture of bottles, has been installed during the same period. The most recent development is the starting in 1931 of a factory for the manufacture of false pearls from glass and chemicals and with machinery all imported from Japan. While the value of the annual output of bangles in India has increased from about Rs. 20 lakhs in 1920 to upwards of Rs. 115 lakhs, there has also been an increase in the value of other kinds of glassware manufactured which is now estimated at about 25 per cent. higher than the Rs. 20 lakhs at which it was put in 1920. For six of the thirty-two factories which produce glass other than bangles, we have received no information as to the nature of the ware manufactured. Sheet glass is made in one factory in the United Provinces; and another factory also in the United Provinces is equipped with plant for the manufacture of ribbed and figured sheet. Bottles and phials are made at twelve factories, three in the United Provinces, seven in Bengal, and two in Bombay. Lampware, globes and chimneys are made in twenty-four factories, that is to say, in all except two of the twenty-six factories the nature of whose products has been reported to us; the two exceptions are a factory in the United Provinces and one in Bombay both of which are reported to make nothing but bottles or phials.

Representations received

5. We have received representations on behalf of twenty bangle factories at Firozabad, and of two other manufacturers of bangles and one manufacturer of false pearls; from four bangle factories whose existence has been reported to us we have heard nothing. Both the manufacturers of sheet glass have stated their case before us. We have received representations from six manufacturers of bottles and from nine manufacturers of lampware. Besides the six factories of which we have heard nothing beyond the mere fact of their existence, there are six manufacturers of bottles and fifteen manufacturers of lampware who have neither made written representations nor appeared before us to give oral evidence. We understand that many of these factories are at present closed. Thus our study of the present condition of the industry has been confined to information supplied by thirty-two* out of the fifty-nine factories whose existence has been reported to us, to detailed answers to our questionnaire prepared by

* 23 manufacturers of bangles and false pearls, 2 manufacturers of sheet glass, 6 manufacturers of bottles, and 9 manufacturers of lampware. The two manufacturers of sheet glass and six of the manufacturers of lampware also make bottles.

the bangle industry at Firozabad and by ten other factories and to the inspections and discussions mentioned in the preliminary paragraphs of this Report.

The manufacture of glass :—1 Raw materials

6. The production of the Indian glass factories is at present confined to soda lime glass, and consists mainly of containers, lampware, bangles and sheet glass. The operations necessary for the production of glass are :—

(1) Selection, preparation and mixing of the raw materials.
(2) The melting of the resulting 'batch' in a furnace.
(3) The manipulation of the melted glass either by hand or by machinery.
(4) The process of annealing.
(5) Finishing operations.

The selection of the raw materials is determined by the nature of the glassware which the manufacturer wishes to produce; and for the manufacture of the glass now made in India the principal raw materials are silica sand, sodium carbonate (soda ash) and lime. In the manufacture of common bangles a mixture is sometimes used which consists of clay, sand and what is called "Reh", an efflorescence from the soil consisting of carbonates, sulphates and chlorides of sodium and potassium. For the successful production of glass it is necessary that the manufacturer should know the exact properties of each of his materials, should mix them in suitable proportions and should mix them thoroughly. We shall consider in our next Chapter how far the glass manufacturer in India can obtain in the country materials possessing the qualities which he requires; in this Chapter we propose to give a brief account of the methods of manufacture at present employed in Indian factories. A simple form of mechanical 'mixer' is commonly but not universally employed. In the United Provinces Glass Works at Bahjoi where sheet glass is manufactured by the Fourcault process, and in the Allahabad Glass Works at Naini where bottles are made on O'Neill and Lynch machines, the materials are used in the proportions recommended for operation by these particular processes. But elsewhere the Indian glass manufacturer uses a high proportion of soda ash in his composition. By this means he produces a glass which melts at a comparatively low temperature and is easy to work; on the other hand an excess of soda ash affects the durability of the glass, and, since soda ash is the most expensive of the principal raw materials, adds greatly to its cost. This excessive use of soda ash is specially noticeable in the bangle industry, in which the batch compositions commonly approximate to one of the three types shown below :—

TABLE II.

Sand	100	100	100
Soda ash	49	45	46
Limestone	24	...	...
Slaked lime	...	4	10
Saltpetre	2	...	6
Borax	1	10	20
Zinc oxide	...	12	...

A mixture in which the proportion of soda ash was limited to 35 parts for every 100 parts of sand would produce a more durable and a cheaper glass and would also produce the correct 'tinkle' in the bangles, which the Indian banglemaker now complains that he cannot get. In the case of manufacturers of blown and pressed ware the proportion of soda ash used is not so great and the durability of their glass is satisfactory, though there is room for improvement in this respect in this branch of the industry also.

2. Furnaces.

7. Since however, any lowering of the soda content of the glass will necessitate a higher temperature to melt it, the furnaces will need such improvement as to render them capable of producing that higher temperature. The furnace in a glass works may be either a pot furnace or a tank furnace; in a pot furnace the glass is melted in pots or crucibles placed in the furnace chamber; in a tank furnace the lower walls of the combustion chamber itself serve as the container for the molten glass. A pot furnace is employed for the production of glass of specially high quality, or of different colours or varieties when the quantities or types required do not warrant the use of a tank furnace. A tank furnace is used when quantity is the main consideration, and especially when glass is formed into articles by machines which require a uniform and steady supply of molten glass. Furnaces may be direct fired, semi-direct fired or fired by oil or producer gas. Most modern furnaces have their heat provided by the combustion of gas produced from coal in an apparatus termed a gas-producer which is separate from the combustion chamber. As the gas reaches the entrance or entrances to the furnace chamber it is mixed with the necessary amount of air for combustion. The air is preheated on its way to the furnace by making use of the heat borne by the outgoing products of combustion. Preheating may be effected either by the regenerative or by the recuperative system. In the regenerative process it is usual to preheat the gas as well as the air. The air (or gas) on its way to the furnace is heated as it passes through a regenerator, a deep chamber, usually rectangular, containing an open-work arrangement of firebrick checkers which retain the heat left by the hot gases on their passage from the furnace. At the entrance to the furnace the heated air meets the gas from the gas producer which has also been preheated by passing through a similar regenerator. The mixture enters the furnace in a state of combustion; and after passing through it the exit gases are led through other regenerators in which they leave some of their heat on their way to the chimney. In order to maintain a high temperature in the furnace it is necessary at regular intervals to reverse the direction of the current, so that the air (or gas) on its way to the furnace may pass through a regenerator which still retains the maximum amount of heat from the exit gases. In the recuperative process this reversal of the direction of the current is unnecessary, for the process is continuous, the air entering the furnace through vertical channels and the exit gases leaving through horizontal passages of the same recuperator; nor is it usual to preheat the gas before it enters the furnace chamber. If gas is passed

through the recuperator on its way to the furnace, the comparatively slow rise in its temperature as compared with the rapid rise in the case of the regenerator may cause dissociation of the gas, impairing its heating value and tending to clog the recuperator passages with soot. It is usually passed direct from the producer into the furnace, care being necessary to prevent it carrying in an excessive amount of dust. Either system can be used to economise the heat produced in either a pot furnace or a tank furnace. Recuperators occupy less space and are cheaper to instal than regenerators; the recuperative process being continuous requires less attention than the regenerative which is intermittent, and it is easier to keep the furnace temperature regular with the continuous recuperative system. On the other hand special refractory materials are necessary for the tubes in the recuperative system, and special care is required to prevent leakage. Since there is a greater reserve of heat in a regenerative furnace, it is more suitable for very large installations, either pot or tank.

Advantages of gas fired furnaces.

8. A gas-fired furnace, with either a recuperative or a regenerative system of preheating, has many advantages over a direct fired furnace, in which the fire box forms an integral part of the combustion chamber. The thermal efficiency of a direct fired furnace is low for several reasons: there is a loss in heating the large excess quantity of air necessary to obtain combustion; there is no means of regulating the supply of air; the gases are drawn so swiftly through the furnace that they only part with a small fraction of their heat; much of the fuel remains unburnt in ashes and exit gases; and only a small proportion of the heat carried away by the exit gases can be recovered by the use of air flues round the fire box. A gas fired furnace on the other hand needs only a slight excess of air to burn the gaseous fuel completely; the heat carried away by the exit gases can be largely transferred to the incoming gas and air; the gas is burned and the heat is produced in the furnace exactly where it is required instead of partially in a fire box distinct from the furnace chamber; the proportions of fuel and air can be controlled exactly, and since the incoming gas and air are preheated before combustion higher temperatures can be attained. Moreover, since the fuel can all be gasified at one place in the works, there is no need to carry fuel from place to place and the works can consequently be kept cleaner and freer from dust; and gas can be produced from the lower grades of fuel which cannot be used economically for direct firing.

Pot furnaces.

9. Furnaces in which the glass is melted in pots or crucibles may be circular or rectangular. In a circular furnace the pots are set round a central fire box or, in a gas-fired furnace, round the 'eye'. The burning gases pass from the fire box or 'eye' round the pots, and are then led from the furnace through flues arranged near the wall of the furnace in front of or between the pots. In the old English type of furnace, the exit flues took off in front of the bottom portion of each pot and led the exit gases upwards into a high cone which was built

over the furnace to serve as a chimney. In the Japanese type of furnace, common in the Indian glass works, the exit ports are arranged between the pots and the exit gases pass downwards into a flue towards the base or surrounding the base of the furnace by which they are led to the chimney. We have seen one rectangular pot furnace in which six open pots line each long side of the furnace. A fire box is placed at each end, while exit flues are arranged similarly to those in the circular furnaces. We have also seen one rectangular gas-fired regenerative pot furnace, which produces a temperature distinctly higher than any of the direct fired type.

Pots.

10. In the smaller bangle factories the 'Reh' composition or block glass bought from other factories is put into small boot shaped pots—each holding about 28 lbs.—and melted in a circular furnace built of ordinary red brick. These factories produce only the cheapest type of common bangles. The other pot furnaces usually employ pots capable of holding 600 or 800 lbs. of 'batch'; and a circular furnace may be built to hold 7, 8, 9 or 10 pots. One factory has used pots with a capacity of 1,600 lb. for the manufacture of figured sheet glass. Some factories still import their pots from Japan, but a gradually increasing number are making their own pots from Indian fireclays and are getting better service from these than from the imported article.

Pot Arch.

11. There is at present one factory in India in which new pots are set while the furnace is maintained in operation. If a raw pot is introduced directly to the high temperature of a working furnace it will fly to pieces immediately. It is, therefore, necessary to heat it up gradually to a temperature between 1,000° and 1,300° C. when it can safely be set in the furnace. This preliminary heating occupies from five to seven days and requires careful regulation. It is done in an auxiliary furnace, termed a "pot arch", which may be of the kiln type, in which the heat is derived from a fire box in the furnace; but the gas-fired type of pot arch is generally preferred, for in it the regulation of the temperature is easier and a higher final temperature can be attained.

Tank furnaces.

12. Tank furnaces are employed in three of the Indian factories. At the United Provinces Glass Works, Bahjoi, the glass for the Fourcault machines is melted in a tank furnace of 300 tons deadweight capacity; at the Allahabad Glass Works, Naini, the bottle machines are fed from tank furnaces of capacities varying from 50 to 140 tons; and at the Calcutta Glass and Silicate Works, where bottles are made by hand, the glass is melted in three small tank furnaces with capacities of 15, 18 and 35 tons. All the furnaces are of the 'cross-flame' regenerative type. A 'cross-flame' furnace is one in which the ports are arranged along each side of the tank above the glass level, those on each side becoming alternately entry and exit ports. These furnaces are all of fairly modern design and are far more efficient than the pot furnaces. Their efficiency might be further

improved by scientific control of the gas production and by some adjustments in furnace dimensions and operation.

13. After the glass is melted in the furnace there are a variety of ways in which it may be manipulated and we shall now briefly describe the methods applied to the different kinds of glassware manufactured in India.

3. Manipulation.

14. The manufacture of bangles has been carried on in India for centuries, and at Firozabad near Agra the older methods of manufacture are carried on side by side with more modern practices. There are a certain number of factories which only make "Block Glass", either colourless (usually of a greyish tint) or coloured. The melted glass is ladled out on to metal plates, allowed to cool, and broken into pieces measuring about 4″ × 4″ × 1″. These pieces are sold to other factories, where either by themselves or with the addition of fresh batch and colouring materials they are remelted and manufactured into bangles. In the more primitive factories common bangles are made by craftsmen who work in pairs. One of them gathers a lump or 'gob' of glass on the end of a pointed iron rod; pressing the glass with a knife against the point of the rod he makes a hole through the middle of it, and then works the glass into a ring which he transfers to a fireclay cone held by his partner. The glass is then pressed down this cone, expanded to the desired size and shaped by pressure between the cone and a fireclay block, in which a groove of the required width has been cut. In some cases both the cone and the block are quite plain; but more often both the groove in the fireclay block and the cone are carved with patterns which by the pressure applied are impressed on the bangle.

(a) Bangles: the old method of manufacture.

15. For the manufacture of better bangles, comparable with the 'reshmi' bangle imported from Japan, simple machinery is used. The glass is gathered on a rod and shaped first into a round lump; it is then rolled on a polished plate or marver into the form of a cone and pointed either by beating it with a flat steel tool or by plunging it downwards into a mould. If it is shaped with the tool it will always need reheating, which is done by inserting the glass, still on the rod, in a coal fired furnace or "glory hole": shaping in the mould is a quicker operation and glass treated in this way may not need reheating. When sufficiently hot it is taken to a winding plant which consists of a cylindrical steel roller which is usually operated by hand, though in one case electric power is employed. Under the roller is a heating device which may be shallow coal fire or a row of small gas jets. With a pair of pincers the point of the glass cone is pulled out into a thin strand and wrapped round the roller. The roller is then rotated at a high speed and the glass is wound on to it in the form of a spiral. The thickness of the strand of glass forming the spiral will depend upon the temperature of the lump of glass from which it is wound and the distance between this lump and the roller. In one factory an iridescing solution is sprayed upon the

Reshmi bangles.

glass while it is being wound on to the roller. The glass spiral is removed from the roller, and when cool is separated into single circlets by the scratch of an emery or carborundum stone or of a steel knife. The broken ends of each circlet are then brought into the same plane and joined in the flames of kerosene oil or gas blow pipes.

Fancy bangles.

16. These bangles may be of plain colours, they may be iridesced as described above, or a light silky appearance may be given by stirring a chemical such as potassium cyanide into the glass before it is gathered. There are countless other varieties of fancy or decorated bangles. Hollow bangles may be made by gathering the glass on a tubular iron rod, blowing it into a hollow bubble and winding it on to the roller in the form of thin glass tubing. These hollow bangles are specially adapted to forms of decoration such as silvering, which is performed by introducing a solution into the circlet before its ends are joined. Any variety of shape may be given to the bangles by manipulation of the glass at its first gathering. Parti-coloured bangles, plain or twisted, are made by suitable manipulation of the glass before it is wound on to the roller. Decoration may be given to any bangle by cutting facets on its surface and marking it with designs in enamel or 'liquid gold'. Bangles decorated in this way have to be heated again to fire or fix the enamels: this is done in a muffle furnace with three chambers each heated to a different temperature, the trays of bangles being moved from one chamber to another.

(b) Lampware.

17. Globes and chimneys are always made by hand processes. A boy gathers a small quantity of glass on a blowing iron and blows it into a round bubble which is allowed to cool; more glass is then gathered on the bubble and the whole is shaped by blowing and the use of the marver or water block; the blower then takes the iron and by swinging and blowing the glass elongates it into a pearshaped bubble which he inserts in the mould. The mould is of iron, in two parts joined by hinges, and may be shaped for the blowing of one, two, three or four globes or chimneys at a time. It is opened by a boy who hangs a strip of wet paper inside one or both parts of it. When the blower places the glass between the open halves of the mould and the bubble is sufficiently elongated to stretch almost the whole length of the mould, the boy closes it and holds it shut while the blower blows the glass to the shape of the mould. The wet paper serves as a lubricant providing steam and carbon which prevent the glass sticking. The mould is then opened and the blown glass laid on a tray and cracked from the blowing iron and carried to the annealing kiln.

(c) Bottles and phials: (i) by hand.

18. Bottles and phials are made by hand and also by machinery. The hand process is the same as that just described for the manufacture of lampware up to the removal of the blown shape from the mould, except that for small bottles there is only one gathering

of glass and only one bottle is blown in a mould at one time. When the bottle, still adhering by the neck to the blowing iron, is removed from the mould it is received in a shaped receptacle on the end of a rod (punty) and the blowing iron is cracked away. The bottle is carried on the punty to a glory hole and the neck is softened. Then by the use of a pincer like tool, which has a spindle to go inside the neck of the bottle and a mould to press on the outside, the mouth of the bottle is formed, the punty being rotated rapidly during the operation on the two lengthened arms of a chair. The bottle is now ready for the annealing kiln. Wide-mounted jars are made in very much the same way; but to form the mouth of a jar it is usual to add a thin strip of molten glass round the neck before using the finishing tool.

(c) by machinery.

19. In the Allahabad Glass Works there are four O'Neill machines and one Lynch machine complete with Miller feeding devices and at the Calcutta Glass and Silicate Works there is an O'Neill machine which has not yet been worked. The operation of the two types of machine is similar. Projecting from the working end of a tank furnace is a feeder chamber or 'boot' into which molten glass can flow freely. A plunger thrust downwards at regular intervals into the 'boot' forces out through an orifice at the bottom lumps or 'gobs' of glass of constant shape and size. These gobs of glass are cut off immediately below the 'boot' by automatically operated sheares and are received in moulds set upon a horizontal revolving table. As the table revolves the mouth of the bottle is formed in the mould and the glass is blown into a pear shaped bubble. At this stage, the glass is transferred automatically to one of a series of bottle shaped moulds on another revolving table and blown to its full size. The mould then opens and the bottle is removed either automatically or by hand for annealing. These machines will produce up to 35 bottles a minute according to the shape and size of the product, but as operated at the works in India have not yet attained an output of more than 20 bottles a minute.

(d) Pressed ware.

20. The market for pressed ware is limited, and the articles made consists chiefly of tiles, tumblers, small dishes and jars, inkstands and paper weights. The gatherer draws on the end of an iron rod more molten glass than is required to fashion the article to be made. He then lets the glass flow into the mould, and the presser, when he thinks that there is enough glass in the mould, cuts off the flow with a pair of shears. The mould is placed below the plunger of a press, and the presser by operating a lever brings the plunger down upon the surface of the glass in the mould. Skill is required to determine the exact amount of pressure needed. The article, the under side of which has taken the shape of the mould and the upper side the shape of the plunger, may be taken straight to the annealing kiln or, in order to remove a dullness produced by contact with the mould and plunger, it may first be roughly fire polished by a short insertion in a glory hole.

21. In one factory the same glass as that used for bottles and lampware is made into glass tubing for the manufacture of test and specimen tubes or syringes. The glass is gathered on a hollow tube or blowing iron and shaped by blowing and rolling on the marver into a bubble of the right size. The bubble is then attached to a piece of glass held on a rod (punty) by a boy and is drawn out into a long tube as the blower and the boy walk away from one another. The tubing is fashioned into the articles required in the flame of a blow pipe.

(e) Glass tubing.

22. Sheet glass is manufactured at one factory by the Fourcault process. The glass is melted in a large tank furnace, with a capacity of about 300 tons, at the end of which four Fourcault machines are operated. Below each machine, floating in the glass is a refractory block called a 'debiteuse'. In the middle of the block for almost its whole length is a slit with highly polished sides. The debiteuse is pressed down into the glass which is forced up through the slit, and caught up by a drawing fork or bait. This bait consists of an iron frame the same length as the slit and is fitted with fork or finger-like projections to which the glass adheres. The bait is raised vertically through the machine, which consists of a series of pairs of asbestos covered steel rollers, drawing after it a sheet of glass of the same width as the length of the slit. Since the pressure of the debiteuse is continually forcing glass up through the slit, and the glass is drawn away as fast as it rises, the process is continuous. The thickness of the sheet is controlled by the temperature of the glass, the pressure on the debiteuse and the speed of the drawing. Above the top pair of rollers the sheet is scratched with a hard steel cutter and then bent, so that it breaks along the scratch. The sheets are then sent to the cutting department where they are cut to the sizes required and defective parts removed.

(f) Sheet glass.

23. One factory is equipped with a machine for the manufacture of figured or ribbed sheet. The melted glass is ladled by hand into the machine where it is passed between rollers by which the desired pattern is impressed on it. It comes out in the form of a sheet on to a table from which it is transferred automatically to the annealing lehr.

(g) Figured and ribbed glass.

24. If glass is chilled or cooled rapidly it becomes strained. It is therefore necessary to control the rate at which glass articles are cooled after they are fashioned; otherwise they would either break while cooling or the majority of them would be so badly strained that a slight shock or change of temperature would shatter them. As glass cools it becomes more and more viscous till it reached a state of rigidity; if it is heated it becomes less viscous or softens; the softer the glass the easier it is to remove the strain. At the lowest temperature at which strain can be removed—"the lower annealing temperature"—the rate of removal of strain or the rate of annealing is very slow. As the temperature is increased the rate of annealing increases until a

4. Annealing.

temperature is reached known as the "upper annealing temperature", above which no residual strain is possible. It follows that the quickest way to remove strain is to maintain the glass at its upper annealing temperature. In practice glass articles, after they have been fashioned, are immediately transferred to a chamber where they are brought to the upper annealing temperature. There the strain is rapidly removed and the articles are then cooled as quickly as is possible without again introducing any strain. If the articles are cooled too quickly the outer portions of glass will become so much cooler than the inside that strain will develop. The actual rate of cooling as well as the upper and lower annealing temperatures vary with the composition of the glass and can only be determined by experiment. The annealing process is carried out either in a kiln or a series of kilns or on a travelling or continuous form of lehr. In some cases the method by which the glass is manufactured renders a separate process of annealing unnecessary. Thus bangles which are wound on to a roller over coal or gas fires need not be separately annealed; and in the Fourcault process of making sheet glass the temperature gradually cools as the sheet is drawn up through the shaft which houses the rollers so that by the time it reaches the last pair of rollers it is almost completely annealed. But the annealing process has to be done separately for all such articles as lampware, pressed ware and bottles. In most of the factories in India annealing is done in kilns or ovens, in which the hot glassware is packed in tiers. When full the kilns are closed up and allowed to cool. When they have cooled down the doors are opened and the goods removed to be finished or to be cleaned and packed. A few of the Indian factories are equipped with annealing lehrs in which the goods are placed upon a tray which is moved slowly from the heated end of an arched tunnel through a gradually falling temperature to the cool end of the tunnel which is kept open. The time occupied in traversing the length of the lehr varies according to the nature of ware being made.

5. Finishing processes.

25. It is only in the case of lampware that any considerable work has to be done after the annealing process is over. In the blowing of globes or chimneys whether singly or in a series of two or more there is always a certain amount of glass to be removed first at the point where the blowing iron has been cracked off, secondly between each article of a series and thirdly at the bottom of the moulded series where the end, which has to be closed in order to permit of blowing, needs to be opened out. This process is done in Indian factories by chipping with a knife, which inevitably produces globes or chimneys with rough jagged ends. These ends are then ground flat upon a rotating iron wheel covered with wet sand. In most factories the grinding is done by hand labour; but one works is equipped with an automatic grinder.

6. Packing.

26. The brittle nature of glassware adds a special importance to the manner in which it is packed for transport to the market and involves the manufacturer in considerable expense under this head. Sheet glass is

packed in wooden boxes. The most up-to-date bangle factories pack bangles first in paper and then in cardboard boxes: but the more general practice is to pack bangles loose in baskets with a little straw, or even to put them loose into a railway wagon without any protection beyond some straw between them and the floor and sides of the wagon. Other glassware is usually first wrapped in straw and then packed in wooden cases, in bamboo crates or in bundles of matting or gunny.

Summary.

27. This completes our survey of the processes of manufacture at present employed in Indian factories. At a later stage in this report we shall discuss the advantages to the industry of extending the use of machinery, particularly in the manufacture of bottles, and we shall note other particulars in which we think that the Indian practice might be improved. For the present it is sufficient to say that it is clear that in recent years the industry in general has made considerable progress in the methods of production, in the kinds of ware manufactured and in the adaptation of the refractory materials available in India to the manufacture of crucibles and furnace blocks.

CHAPTER II.

Natural Advantages possessed by the Indian Glass Industry.

The Fiscal Commission's first condition.

28. The first of the conditions laid down by the Fiscal Commission which should be satisfied by an industry applying for protection is that it must possess natural advantages in the form of an abundant supply of raw materials, cheap power, a sufficient supply of labour or a large home market. It is therefore necessary to consider how far the glass industry in India satisfies this condition.

Raw Materials.

29. The raw materials used in the manufacture of glass may be classified under the heads of:—

(1) Essential glass-forming substances—

(a) Acidic oxides.

(b) Basic oxides

(2) Oxidising agents.

(3) Reducing agents.

(4) Colouring agents.

The materials used by Indian manufacturers of glassware are, among acidic oxides, principally silica which is obtained from sand, sandstone or quartzite rock, and to a small extent boric oxide which is used in the form of borax. The most important of the basic oxides are sodium oxide which is generally introduced in the form of sodium carbonate (soda ash) and occasionally in the form of sodium sulphate (salt cake), and calcium oxide, obtained from limestone, quick lime or slaked lime Other basic oxides occasionally used in India are zinc oxide which is employed only in the manufacture of selenium red glass, and barium carbonate which is used by one manufacturer of bangles to add brilliancy and weight to his glass. Oxidising agents are introduced to serve various purposes; they may be required to decompose organic matter and so prevent discoloration of the glass or they may be used to maintain oxidising conditions in substances which would otherwise be reduced too quickly; the material most commonly used for these purposes in Indian glass factories is potassium nitrate or saltpetre. The only reducing agent at present used in Indian glass factories is zinc dust which is used in some bangle factories in order to produce the conditions necessary for the formation of selenium red glass. Several colouring agents are employed, especially by bangle-makers, the most important being selenium and cadmium sulphide. It may be noted that colouring agents are not only used to produce colour in the glass; when the glass is discoloured by impurities in the

materials, it is a common practice to add to the batch such colouring agents as will neutralise the discoloration and so produce colourless glass.

Sand :—Qualities of glassmaking sands.

30. Silica, which is the principal constituent of commercial glass, is obtained from sand, sandstone or quartzite rock. Wherever it can be obtained sand is preferred because its use saves the expense of crushing stone or rock to the degree of fineness required. The term 'sand' connotes not a substance of some particular composition, but a substance which consists of grains of a particular size, the limits being generally regarded as 0·1 mm. diameter for fine sand and 1 mm. diameter for coarse sand. When sand cannot be obtained sandstone or quartzite offers a suitable substitute; but the sand obtained by crushing stone or rock, even if it be washed and graded after crushing, is not so even as sand graded by natural means; and of course the crushing and any subsequent treatment tend to increase the cost. The choice of sand for glass manufacture should depend upon its purity, its grading, and its cost; and the relative importance of these three considerations will be determined by the quality of glass to be manufactured. The best quality of glass can only be made from the best kind of sand; and the standard of purity for the best sand is that it must contain not less than 99 per cent. of silica and not more than 0·05 per cent. of iron oxide or other iron compounds equivalent to that amount. The objection to the presence of iron in the sand is that it colours the glass as shown below:

Percentage of iron oxide in the glass.	Colour of glass.
0·02	Colourless.
0·02—0·05	Almost colourless.
0·05—0·10	Very pale green.
0·1—0·3	Pale green.
0·3—1·0	Green.
1·0—2·0	Dark green.

When the iron oxide content of the glass does not exceed 0·1 per cent. it is possible to neutralise the green tint by the introduction into the glass batch of materials which tend to produce a purple or reddish purple colour, and the result is a colourless glass, but slightly less bright and transparent than if no colouring materials had been employed. Where the iron content exceeds 0·1 per cent. attempts to decolourise merely result in giving the glass a dull and greyish appearance, which is more unpleasant than the greenish colour caused by the iron oxide. It is thus

evident that the presence of iron oxide in excess of 0·1 per cent. makes the manufacture of bright colourless glass impossible. The limits beyond which the presence of iron oxide renders sand unsuitable for the manufacture of the various kinds of glass may be stated as follows: –

TABLE III.

Type of glass.	Percentage of iron oxide admissible
For best glass, optical and table ware .	less than 0·02
For pressed tableware, white bottles and jars, mirrors, best sheet and plate	less than 0·06
For chemical glassware	less than 0·10
For pale green glass for bottles, jars, common plate and sheet	less than 0·30
For dark green or amber	less than 1·00
For [illegible] glass [illegible] .	up to 7·00

Sand may contain impurities other than iron oxide these are not necessarily harmful in themselves, but their presence in considerable quantities indicates the possibility of inequality in the composition of the deposit from which the supply is obtained. The regular grading of sand is important, because unevenness may result in irregular melting and the presence of blemishes in the glass. It is even more important that there should be no very large or very fine grains than that the general average of grains should be fine, and since the finest grains always tend to contain a higher proportion of iron oxide, it is all the more necessary to remove grains below 0·1 mm. in diameter. At least 70 per cent. of the sand should consist of grains between 0·25 and 0·5 mm. in diameter, or, to adopt the terms of another standard, all the sand should pass a 20 mesh sieve, 95 per cent. passing a 30 mesh sieve and remaining on a 120 mesh sieve; sand passing a 120 mesh sieve should be rejected. A 30 mesh sieve is one containing 30 holes or meshes per linear inch, and the standard sieves employ wire which is exactly the same size as the mesh.

Deposits of sand in India.

31. All the sand used in Indian glass works is obtained from deposits in the country. From the publications of the Geological Survey of India, from information supplied by Dr. Drane and from the evidence of the glass manufacturers we have ascertained that deposits of sand, sandstone or rock suitable for use in the manufacture of glass have been located in every province of India, except the North-West Frontier Province, Assam and Burma. Particulars are given in the following statement:—

TABLE IV.

Deposits of sand suitable for glass making.

Province or State.	Location.	Nature of deposit.	Source of information.	Factories supplied.
Punjab	Jaijon (near Jullunder)	Rock*	Dr. Drane. United Provinces Glass Works and other factories.	Upper India Glass Works, Ambala.
United Provinces	Loghra (near Naini)	Rock*	Mr G. V. Hobson (Records of Geological Survey of India, Vol LIX) Several factories.	Ogale Glass Works. Paisa Fund Glass Works. Kandivli Bangle Factory. Firozabad Bangle Factories. Hardeo Glass Works, Dacca. Allahabad Glass Works, Naini. Calcutta Glass and Silicate Works. P M N Mehta's Bangle Factory, Calcutta.
Do.	Bargarh (near Naini)	Do.	Mr G. V. Hobson (Records of Geological Survey of India, Vol LIX) Dr Drane Several factories	United Provinces Glass Works. Firozabad Bangle Factories. Hardeo Glass Works, Dacca. Bengal Glass Works, Calcutta. Calcutta Glass and Silicate Works.
Do.	Panhal (Banda District)	Do.	Dr Drane United Provinces Glass Works, etc.	Calcutta Glass and Silicate Works.
Delhi	.	Not known	Dr Drane	Not known
Rajputana—Jaipur State	Sawai Madhopur	Rock*	Dr Drane United Provinces Glass Works.	United Provinces Glass Works. Firozabad Bangle Factories. Hardeo Glass Works, Dacca.
Bundi State	Barodhia	"Grit"	Mr G. V. Hobson (Records of Geological Survey of India, Vol. LIX)	Not known.
Bihar and Orissa	Mangal Hat (Rajmahal Hills)	Sandstone	Mr G. V. Hobson (Records of Geological Survey of India, (Vol LXIV)	Do
Do.	Patraghatta (Rajmahal Hills).	Do.	Do	Do
Central Provinces	Jubbulpore	Sand	Mr G. V. Hobson (Records of Geological Survey of India, Vol LIX)	Shri Onama Glass Works.
Baroda State	Pedhami	River sand	Do	Not known.
Do.	Sankheda	Sandstone	Do.	Do.
Madras	Ennore	Sand	Dr Drane	Do.
Do.	Ennanore	Do.	Do.	Do

In addition to these deposits, Mr. Hobson† mentions limestones in the vicinity of Garhi Habibullah and Muzaffarabad which contain accumulations of large masses of soft granular almost powdery silica, material possibly suitable for the purpose of glass manufac-

* Mr. I. D. Varshnei of the United Provinces Glass Works and President of the All-India Glass Manufacturers Association says that the material at these places occurs in the form of large boulders naturally decayed and soft enough to crumble with the fingers.

† Records of the Geological Survey of India, Volume LXII, 1929, page 69.

ture. The factories at Ambala and Firozabad, those at Talegaon (near Poona) and Ogalewadi (Satara District) in the Bombay Presidency and one of the factories in Calcutta have stated that they can get in their immediate neighbourhood supplies of sand suitable for the manufacture of certain qualities of glass. We have also seen a reference to deposits in Bikanir and sand suitable for glass making, but have not been supplied with particulars of their nature.

Quantity and price of Indian sand.

32. We have not been able to obtain any information regarding the extent of sand deposits in India; but since so many of the factories get their supplies from Loghra and Bargarh near Naini, the absence of complaints that the price has been raised by competition indicates that these deposits are very extensive and that the present demands can be met without difficulty. The cost at site has been variously stated by different factories at figures between 3 and 5 annas a maund, or from Rs. 5 to Rs. 8-12-6 a ton. The difference in price is apparently due to the fact that some factories themselves work quarries which they have taken on lease, while others get their supplies from contractors. A factory situated near the deposits, like the Allahabad Glass Works at Naini, which works its own quarries, can get its supplies delivered at the factory for Rs. 8-6-0 a ton. For sand obtained from some of the other deposits we have been given even lower estimates of cost. The transport of sand from Naini to Calcutta involves the charge of freight on a railway journey of more than 500 miles, and to Bombay the distance is over 800 miles. Thus the cost of Loghra or Bargarh sand at a factory in Calcutta is about Rs. 15 a ton, while a factory near Bombay has to pay more than Rs. 25 a ton. The fact that these heavy freight charges do not prevent the use of this sand at such distant places is sufficient evidence that the actual cost of the sand is not uneconomical.

Chemical analyses of sands.

33. We have next to consider how far the quality of the Indian sands which we have found to be available in sufficient quantity and at moderate prices, justifies their claim to be considered suitable raw material for the glass industry. Professor P. G. H. Boswell in his "Memoir on British Resources of Sands and Rocks used in Glass Making" gives the chemical analysis of four Indian sands which he says are the best of nineteen samples of Indian sands supplied to him by the Director of Geological Survey of India at the instance of the Indian Industrial Commission. In 1917, Professor W. E. S. Turner of the Department of Glass Technology at Sheffield University made an analysis for the Director of Industries, United Provinces, of sample of sand from the deposits near Naini. Dr. Drane has analysed 10 sands from samples supplied by provincial Directors of Industries and by glass factories, which may be taken as typical of the sand actually used by the industry. And three or four factories have given us analyses of the sands which they are at present using. The results of all these analyses are set out in the following table:—

Table V.

Chemical Analyses of Indian Sands.

		SiO_2	TiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	K_2O	Na_2O	MnO	Mn_3O_4	Cl	H_2O	Alk. H_2O	Loss on ignition	TOTAL
Analysis made by Mr. G. Macdonald (Bull. of Indian Industries and Labour No. 19, 1922, p. 17).																
Patharghatta		96·00	.	1·15	trace	trace	trace	2·60		.	..	.	..	..	0·25	100·00
Analyses made by Prof. Bosanll (Bull. of Indian Industries and Labour No. 19, p. 17).																
Naini*	1	98·95	0·06	0·39	0·02	0·11	..	0·08	0·02	..	.	.	..	..	0·34	[illegible]
Podhamli	.	98·10	0·17	0·84	0·04	0·15	0·07	..		0·08	.	..	..	..	0·63	100·08
Sankheda	.	99·30	0·07	0·11	[illegible]	0·15	0·03	..	..	.	..	.	..	..	0·20	100·01
Sunere	1	97·53	0·09	1·02	0·04	0·14	0·13	0·38	0·24		..	trace	.	..	0·35	99·91
Analyses made by Prof. Turner, Department of Glass Technology, Sheffield University.																
Naini	2	99·40		0·47	0·057	0·06	0·05	..	..	..	..	.	..	.	0·28	100·317
Analyses made by Dr. Deane (Butler Technological Institute, Cawnpore).																
Bargarh	1	97·58	..	1·52	0·16	trace	0·18	.	.			.	..	.	0·06	100·46
Jubbulpore		98·04	0·63	0·91	0·14	trace	0·09		.			.	..	..	..	99·81
Lohgarh	1	99·00	0·14	0·36	0·10	0·06	0·11	..	..		..	..	..	..	0·13	99·90
	2	98·30	0·07	0·92	0·15	0·06	0·17				..	..			0·14	99·81
		96·54	0·26	1·60	0·25	0·11	0·54		..	.	..	..	..	..	0·40	99·70
Sawai Madhopur	1	98·44	..	1·17	0·33	0·09	trace			.	..	..	..	.	0·43	100·46
Pundal		97·54	0·08	1·05	0·11	0·05	0·05			.	..	..	..	..	0·30	[illegible]
Delhi	.	97·22	1·40	0·36	0·21	0·15	trace	..		..	..	..	..	..	0·41	[illegible]

[illegible] 2	97·13	0·[illegible]	0·[illegible]	0·14	0·10	Nil	..	..	..	..	..	..	..	0·11	[illegible]
[illegible]	97·42	0·12	0·11	0·24	0·10	trace	..	..	..	..	..	..	..	0·24	[illegible]
Analysis made for the Allahabad Glass Works by the Department of Glass Technology, [illegible] University.															
Loghra	97·55	0·10	0·[illegible]	0·17*	0·0[illegible]	0·0[illegible]	0·0[illegible]	0·0[illegible]	0·05	..	..	..	..	0·[illegible]	[illegible]
Analyses made for the United Provinces Glass Works by the Indian Technological Institute, Cawnpore.															
Bargarh 2	[illegible]	.	0·61	0·51	.	..	..	..	..	.	..	.	.	..	99·[illegible]
Sawai Madhopur 2	[illegible]	..	0·6[illegible]	0·40	0·01	.	.	.	..	.	.	..	..	..	100·01
Analysis made for the Calcutta Glass and Silicate Works by Messrs. R. V. Briggs & Co., Bargarh.															
Bargarh 3	95·9[illegible]	.	1·70	0·[illegible]	0·52	0·34	..	..			.	.	0·71	..	100·00
Analysis made for the Calcutta Glass and Silicate Works.															
Bengal	92·50		0·[illegible]		2·20	1·60	..			4·50		2·00	..	..	100·00
Analysis made for the Paisa Fund Glass Works, Talegaon, by the [illegible] Institute, Poona.															
Bargarh 4	94·[illegible]		2·43		1·30	0·87							..	0·60	99·[illegible]
Analyses made for the Ogale Glass Works, Limited.															
Gokak	92·3	Nil	2·00	1·60	3·00	1·10	..			.		.	.	0·6	100·60
Goa	97·4	Nil	1·4	0·5	1·00	Nil	.			.	.	.	..	0·1	100·9
Analysis made at the Government Test House, Alipore.															
Jubbulpore† Green sand	91·06	0·73	4·52	1·32	trace	trace	1·10		..	.	.	..	..	1·40	100·[illegible]

* This analysis is quoted by Prof. Boswell (British Resources of Sands and Rocks used in Glass Making, 1918, p. 157) as of Jubbulpore sand used in the Allahabad Glass Works. On the other hand, C. S. Fox (Bull. of Indian Industries and Labour No. 29, 1923, p. 12) quotes it as for Naini sand. From correspondence produced by the Director of Geological Survey it is clear that this sand as also the Naini 2 sand analysed by Prof. Turner comes from the Loghra or Bargarh deposits about 10 miles from Naini.

† The high iron content of this sand makes it unsuitable for the manufacture of glass other than dark green or black bottles. Its high alumina content might but need not necessarily prevent devitrification.

To facilitate comparison analyses of typical European and American sands are given in a separate table below:—

TABLE VI.

Chemical Analyses of European and American sands.

—	SiO_2.	Al_2O_3.	Fe_2O_3.	CaO.	MgO.	Alkali.	Loss on ignition.	Total.	Remarks.
British.									
Lynn . .	98·82	0·56	0·06	0·16	0·02	..	0·33	99·95	[illegible] Boam's Double washed.
French.									[illegible]
Fontainebleau .	99·50	0·23	0·03	.	..	.	0·22	99·98	[illegible]
Belgian .	98·64	0·62	0·06	0·31	0·13	0·45	0·12	100·34	[illegible]
German.									[illegible]
Hohenbocka .	99·70	0·35	0·05	.		.	0·10	100·20	
American.									
Berkley Springs W. Va.	99·65	0·11	0·02	0·12	trace	..	0·23	100·13	Crushed rock.

We have already seen that for the glass manufacturer one of the most important things to know about his sand is its iron oxide content. Hence the analyses which do not show the iron oxide content separately from that of alumina are of little or no use to him. Of the samples analysed, those dealt with by Professors Boswell and Turner compare not unfavourably with the European and American sands. And the difference between their results and those obtained by Dr. Drane and the analysts employed by the glass works suggests that the samples analysed by Professors Boswell and Turner must have been subjected to some form of purification before they came to them for examination. This inference is confirmed by a letter from Professor Turner to the Director of Industries, United Provinces, in which he says that the sand which he analysed appeared from microscopic examination to have been washed before it was sent to him. A consideration of all these analyses, and especially of the four samples from Bargarh and the three from Jaijon, suggests that the deposits from which the factories draw their supplies yield sands which vary considerably in composition from one consignment to another and indicates the necessity, if the manufacture of glass of good quality is to be successful, of selecting the sand with care, and of washing and grading it before use, in order that the impurities of which the analyses disclose the presence may be removed. The Allahabad Glass Works testify to the improvement made by washing their sand; for they inform us that a whiter or less coloured glass is in this way obtained for the manufacturing of lampware. While Dr. Drane's analyses indicate that the sand as now used in glass works is not suitable for the manufacture of glass of the highest quality or colourless glass—a conclusion which is confirmed by the appearance of the finished articles at the various works which

we have visited—it is established by the analyses made by Professors Boswell and Turner that there is sand in India which by suitable treatment can be rendered fit for the manufacture of the best glass.

Mechanical analyses of sands.

34. The other point for consideration in determing the suitability of sand for the manufacture of glass is the evenness of its grading. Here again Professors Boswell and Turner give results for Indian sands comparable with European and American sands.

TABLE VII.

Mechanical analyses of Sands.*

—	>1 mm.	>0·5 <1·0	>0·25 <0·5	>0·1 <0·25	>0·01 <·1	<0·01	Total sand Grade >0·1 mm.
Kaimi		Few grains	91·1	8·4	0·1	0·4	99·5
Pathamati	0·5	11·5	65·4	19·8	1·4	1·4	97·2
Sankheda	.	9·9	70·7	17·7	0·3	1·2	98·3
		Figures for sands for comparison are :—					
Fontainebleau			70·3	28·3	0·6	0·9	98·6
Lynn D W	.		90·8	8·7	0·2	0·8	99·5
Belgian	0·7	6·5	91·0	1·4	0·4		99·6
Berkley springs		1·5	97·1	0·8	0·2	0·4	99·4

Professor Turner and Dr Deane have expressed the results of their analyses in terms of the percentage of sand retained on meshes of different sizes as shown below :—

TABLE VIII

Mechanical analyses of Indian sands and crushed rocks.

—	Percentage of sand retained successively on					Through Mesh 100
	Mesh 30.	Mesh 60.	Mesh 80	Mesh 90	Mesh 100	
Analysis made by Professor Turner						
Kaimi	0·65	80·43		.	17·1	1·55
Analyses made by Dr Deane.						
Pumhal	66·3	30·6	1·6	0·4	0·1	1·2
Jaijon 1	0·1	41·5	24·2	3·5	0·6	30·1
Jaijon 2	28·0	43·6	10·4	2·0	0·6	15·2
Jaijon 3	0·2	5·3	10·6	3·5	2·4	75·8
Bargarh	11·3	48·5	18·8	2·2	1·2	19·0
Delhi	34·5	46·3	8·8	1·2	0·2	9·5
Sawai Madhopur	14·4	54·5	8·9	2·5	0·6	19·1
Jubbulpore	18·6	66·2	8·9	1·4	0·4	4·6
[illegible]	73·7	18·8	6·9	0·1	0·1	0·4
[illegible]	83·7	15·8	0·2	0·1	0·1	0·1
Analysis made for Paisa Fund Glass Works by Ranade Institute, Poona.						
Bargarh	..	47·4	..	46·1	..	3·5

* Analyses made by P. G. H. Boswell, loc. cit.

For the purpose of rough approximation it may be assumed that grains above 0·5 mm. will remain on a 30 mesh sieve and that grains smaller than 0·1 mm. will pass through a 120 mesh sieve. Adopting this method of expressing Professor Boswell's results in the terminology of the test used by Professor Turner and Dr. Drane, we arrive at the following comparison:—

TABLE IX.

Approximate mechanical analyses of Sands and Crushed Rocks.

	Above 30 Mesh.	Between 30 and 120.	Through 120 Mesh.
(1) *European and American Sands analysed by Professor Boswell*—			
Fontainebleau	...	98·6	0·6
Lynn D W.	...	99·5	0·2
Belgian	6·5	92·4	0·4
Berkeley	1·5	97·9	0·2
(2) *Indian Sands analysed by Professor Boswell*—			
Naini	Few grains	99·5	0·1
Pedhamli	11·5	85·2	1·4
Sankheda	9·9	88·4	0·5
(3) *Indian Sand analysed by Professor Turner*—			
Naini	0·65	97·98	1·1
(4) *Indian Sands analysed by Dr. Drane*—			
Panhai	66·3	32·5	1·2
Jaijon 1	0·1	69·8	30·1
Jaijon 2	28·0	56·8	15·2
Jaijon 3	0·2	24·0	75·8
Bargarh	11·3	70·5	18·0
Delhi	34·5	56·0	9·5
Sawai Madhopur	14·4	66·5	19·1
Jubbulpore	18·8	76·8	4·4
Ennore	79·7	19·9	0·4
Ennanore	83·7	16·2	0·1
(5) *Sand analysed for Paisa Fund Glass Works by Ranade Technical Institute, Poona*—			
Bargarh	Not determined	About 96·5	3·5

The only inference which can be drawn from these results as shown in Tables VII, VIII and IX is the same as that suggested by the chemical analysis of the Indian sands. The results given by Professors Boswell and Turner indicate that there is sand in India as good as the best of the European or American sands; Dr. Drane's results show that the sand as supplied to the glass works is too uneven in grade to permit of regular melting and of the production of glass free from blemishes caused by seeds or

bubbles; and they emphasise the necessity for careful selection at the source of supply, and for systematic grading as well as washing of the sand before use.

Purification of Indian sands.

35. We are satisfied by the information to which we have had access that there are in India abundant supplies of sand available at moderate prices and suitable for use in the manufacture of the inferior qualities of glass. In the interests of the industry it is desirable that the various sources of supply should be systematically examined, the extent and composition of the deposits ascertained and an accurate estimate formed of their true values. It is possible that such investigation might bring to light deposits of such pure and constant composition as to be suitable without further treatment for the manufacture of the best glass. But even without such a discovery it is evident from the analyses made by Professors Boswell and Turner that the deposits now being worked produce sand which, by proper treatment before use, can be brought to a state of purity and evenness of grade comparable with that of the best European and American sands. If a manufacturer wishes to obtain sand suitable for the manufacture of 'white' glass, he must first see that the sand is collected from a deposit of ascertained quality, and he must also wash and grade it before making use of it in his factory. These operations will of course add to the cost of his sand. But if by the additional expenditure the desired improvement in the quality of his glassware can be effected and higher prices obtained, it is certainly worth the manufacturer's while to make a careful study of the question. The following very rough calculations will give an indication of the manner in which the problem might be approached. The sand may be treated either at the quarry or after delivery at the factory. We first assume treatment at the factory, and make a rough estimate of the cost of the plant necessary to treat 5 tons of sand a day at a factory. The machinery, washer, drier and sifter, may cost £2,100 or Rs. 28,000. Interest at 10 per cent on this capital expenditure will be Rs. 2,800 and depreciation at 10 per cent will be Rs. 2,800. The extra labour required to work this plant may cost Rs. 12,000 a year; and the same amount should suffice for the fuel and water required. We thus get an annual expenditure of :—

	Rs.
Interest	2,800
Depreciation	2,800
Labour	12,000
Fuel and water	12,000
	29,600
or approximately	30,000

5 tons of sand a day for 300 days make 1,500 tons used in the year; the extra cost comes to Rs. 20 per ton of sand. If we assume that about 1,700 lbs. of sand are required to produce a ton of melted

glass, a ton of sand will produce about 2,950 lbs. of melted glass. In the process of manufacture there is a loss by wastage, breakage, and in other ways of 25 to 30 per cent.; but all the loss of sand except about 5 per cent. can be recovered and added to future glass batches in the form of cullet. Thus deducting 5 per cent. from 2,950 lbs., we get about 2,800 lbs. of finished glassware as the yield from a ton of sand. And if, as we have been informed, 40 gross of small sized phials weigh about a ton, we get 50 gross as the yield from a ton of sand; and since the extra cost per ton of sand is Rs. 20 the extra cost per gross of phials will be 6·4 annas. But if manufacturers were to combine with the owners or lessees of large quarries like those at Loghra and Bargarh to instal the plant and treat the sand at the quarry the extra cost would be greatly reduced. In the first place, the expenditure would not all be in excess of that now incurred; for the sand at Loghra and Bargarh occurs in the form of soft rock, which now has to be crushed before the sand can be sent to the factories; and the expenditure incurred on this operation should be set off against the expenditure now proposed. Further, the two largest and best equipped factories in India are the Allahabad Glass Works at Naini and the United Provinces Glass Works, Bahjoi, which are situated sufficiently near each other and to the sand deposits to undertake the treatment of the sand jointly at the quarry. Their total capacity is not less than 15,000 tons of glass a year. On the assumption that the 11,250 tons of sand required annually for this output of glass is supplied from one quarry, the cost of the machinery, crusher, washer, drier and sifter, might come to £7,500; adding £1,500 for contingencies, we get a figure of £9,000 or Rs. 1,20,000 for the capital expenditure required. Interest on this amount at 10 per cent. comes to Rs. 12,000 a year, and depreciation at 10 per cent. to a similar figure. For supervision and labour expenditure of Rs. 50,000 a year might be necessary; and fuel and water might cost Rs. 50,000 a year. Thus we get an annual expenditure of:—

	Rs.
Interest	12,000
Depreciation	12,000
Labour	50,000
Fuel and water	50,000
	1,24,000

The extra cost for 11,250 tons of sand comes to Rs. 11·02 a ton, less the amount now spent on crushing. If a ton of sand may be taken as equivalent to about 2,800 lbs. of finished glass, or 50 gross of phials, the extra cost of a gross of phials will be 3·52 annas. But even if a joint arrangement for the treatment of sand at the quarry prove impossible in the immediate future, the calculation we have made for the treatment of sand at the factory shows that at an extra cost for sand of little more than six annas per gross of phials the manufacturer ought to be able to produce white glass;

and there can be no doubt that the additional price he would obtain for white as opposed to coloured bottles would compensate him for this additional expenditure on sand. It will also be realised that the production of white glass by the Indian manufacturer will enable him to undertake the manufacture and sale of several classes of superior glassware which are not now made in the country and the production of which will assist considerably in extending his output and reducing the general level of costs.

Boric oxide

36. The only acidic oxide, other than silica, to which reference need be made is boric oxide, which is generally introduced in the form of borax, the use of which involves the addition to the glass batch of sodium oxide as well as boric oxide. It is therefore necessary to know exactly the chemical composition of the borax used, and to make a reduction where required in the quantity of soda ash included in the glass batch proportionate to the quantity of sodium oxide contained in the borax. Borax is twice as expensive as soda ash and consequently is not used in excess of the quantity necessary to produce the effect desired. It is often used in coloured glasses as a solvent of colouring oxides, and it is also used in order to reduce the co-efficient of expansion of the glass, or to increase its toughness and chemical resistence. One factory, which has stated the quantities used, adds about 10 parts of borax for every 100 parts of sand. Borax is imported into India from Tibet, and thus, though not actually a product of India, is obtainable so easily and in such large quantities that the nearness of Tibet, the source of supply, may be considered as a natural advantage of the glass industry in India.

Soda ash and Saltcake

37. The sodium oxide required for the manufacture of glass may be introduced in the form of sodium carbonate (soda ash) or sodium sulphate (saltcake). We have seen that small quantities may also be introduced by the use of borax. Modern manufacturers generally prefer to use soda ash, which does not require such a high temperature in the furnace as saltcake and consequently makes for economy of fuel; soda ash, moreover, does not make so severe an attack upon the refractory materials in the furnace; nor is it so liable to produce blemishes or discolouration in the glass. While saltcake is not so expensive a material as soda ash, it gives only 43·7 per cent. of sodium oxide as compared with 58·5 per cent. given by soda ash; to produce a stated quantity of sodium oxide it is therefore necessary to use about 33 per cent. more saltcake than soda ash and any saving effected by the lower price of saltcake in India is not sufficient to cover the cost of the greater quantity which has to be used. In tank furnaces however it is generally advisable to add a small quantity of saltcake in order to avoid the formation of a scum on the surface of the glass, though in small tanks such as those used by the Calcutta Glass and Silicate Works this is probably unnecessary. Thus it is only in the United Provinces Glass Works at Bahjoi and the Allahabad Glass Works at Naini, where

the glass is melted in large tank furnaces, that any saltcake is used; and even in these factories it is used in addition to and not as a substitute for soda ash. Another form in which sodium oxide is used is the salt earth obtained from the 'Reh' deposits in the United Provinces; this is employed only for the manufacture of the cheapest form of bangles and is not of sufficiently good quality to be used for anything better. The main function of sodium oxide in glass manufacture is to act as a flux; and the higher the proportion of soda the more readily the glass is melted and the more easily it is worked. On the other hand, a high soda content decreases the durability of glass and renders it more liable to attacks by the atmosphere and by liquids with which it comes in contact. Glass containing more than 18 per cent. of sodium oxide is attacked quickly on exposure, becomes dull and dirty in appearance and containers made from it are likely to contaminate their contents. We have already seen that a common feature of Indian glass manufacture, especially in the bangle making industry, is an excessively high percentage of sodium oxide caused by the use of large quantities of soda ash in order to facilitate melting. The compositions used in bangle making which have been given in paragraph 6 produce glass of approximately the following composition:—

TABLE X.

Silica .	69·8	67·6	67·8
Sodium oxide (including K_2O from saltpetre)	20·5	19·9	22·1
Calcium oxide .	9·4	2·1	5·2
Boric oxide	0·3	2·4	4·9
Zinc oxide . . .	..	8·0	...

The sodium oxide contents are too high in all these glasses; all of them are subject to attack by the atmosphere; and all of them are unnecessarily costly.

Indian sources of supply.

38. Deposits of sodium carbonate and sodium sulphate occur in different parts of the country. Crude sodium carbonate, contaminated with varying amounts of common salt and sodium sulphate, is found as an efflorescence in certain districts in the hot weather. We have seen that the alkaline earth or 'Reh' is collected and used for the manufacture of common bangles at Firozabad. During the war the exploitation of these deposits was stimulated by the high prices of the imported article and fairly pure sodium carbonate was extracted both in the United Provinces and in Mysore. But when prices fell the methods of extraction employed ceased to be economical. In Sind and especially in the Khairpur State there are considerable deposits of sodium carbonate—also in some cases crude and mixed with chloride and sulphate—which occur in the basins of certain lakes; and similar deposits have been found in Berar and in Rajputana. A more promising source of supply is in the

Shri Shakti Alkali Works recently established by the Dhrangadhra State in Kathiawar, where soda ash is manufactured from the abundant supplies of salt in the brine wells of the Runn of Cutch by what is known as the ammonia-soda process. In this process a reaction between ammoniated brine and carbon dioxide produces sodium bicarbonate, which is converted by calcination into soda ash. This factory worked for about six months in 1930. Most of the glass factories tried its soda ash and found the quality satisfactory. Financial difficulties forced it to suspend operations early in 1931, but preparations for restarting it are almost complete and it is expected to resume work about the end of this month. We are informed that the plant is designed to produce 60 tons a day and if worked to capacity should produce not less than 18,000 tons a year which is far more than the glass industry needs at present. Sodium sulphate is produced in fairly large quantities as a by-product in the manufacture of hydrochloric acid. But it is by no means certain that the glass industry can count on supplies from this source. For, as we observed in paragraph 55 of our Report on the Heavy Chemical Industry, that industry itself will require for the manufacture of other chemicals practically the whole of the salt cake likely to be produced when the production of hydrochloric acid reaches its maximum. Most of the factories at present get their supplies of soda ash from Imperial Chemical Industries, Limited, who import their own manufactures and also soda ash obtained from natural deposits at Magadi in East Africa; but Russian soda ash has recently been placed on the Indian market by the Havero Trading Company and has been used by some of the glass works. The total quantity and the average value of the imports of soda ash in each of the last five years have been :—

TABLE XI.

	Quantity cwts	Average value per cwt. ex duty.
		Rs.
1926-27	900,178	5·87
1927-28	1,061,185	5·65
1928-29	1,076,634	5·80
1929-30	1,204,059	5·90
1930-31	1,052,164	6·13

Full data are not available on which to calculate how much of these imports are used in the glass industry. The actual quantity of glass produced by the Indian factories is not definitely known. Nor does the quantity of soda ash used in the manufacture of glass always constitute the same proportion of the batch. But if we assume a total production of 20,000 tons of glassware a year and if 25 per cent. of this represents the quantity of soda ash used in its manufacture, the industry would require about 5,000 tons of soda ash a year or about 1/10th of the total quantity imported.

39. When the glass industry applied for protection in 1927, it was suggested by the Government of India that the industry could not be said to enjoy any natural advantage while it was dependent on imported soda ash, because the cost of soda ash formed a large percentage of the total cost. The Fiscal Commission, in laying down their first condition, recognised that the relative importance of the natural advantages mentioned in it would vary according to the circumstances of each industry and that in examining the claim of an industry to protection it was essential to determine the relative importance of any natural advantages which might be lacking. Soda ash is at present imported by the Indian glass industry although, as we have pointed out, the materials required for manufacturing it are present in India and there is already a well-equipped plant capable of producing a substantial proportion of India's requirements. Even if the industry was confined permanently to the use of imported soda ash, we should still be hardly justified in rejecting the claim to protection unless it was found that on the balance the industry did not possess sufficient natural advantages. Judged by the quantity of the principal raw materials used, soda ash does not exceed 25 per cent. of the total quantity according to the practice followed in the more efficient factories in India. Sand represents the largest proportion of the raw materials used and constitutes in fact the bulk of the material contained in finished glass. If the importance of the various raw materials is considered with reference to the proportion in which they enter into the composition of glass, soda ash is of much less importance than sand.

Dependence on imported materials not a bar to protection.

40. Soda ash, however, is an essential ingredient in the manufacture of glass and in every country its cost is higher than that of the other materials and forms a considerable proportion of the total cost of production. The proportion of the cost of soda ash to that of other materials in the sheet glass industry in different countries is shown in the following table, the quantity of each material per unit of glass being assumed to be the same as in the Indian industry:—

Proportionate cost of soda ash in glass manufacture.

TABLE XII.

	Indian.	English.	Belgian.	German.
Sand	17	24	9	13
Soda ash	65	50	74	71
Salt cake	12	8	13	8
Limestone	6	18	4	8
	100	100	100	100

On the same assumption the percentage costs of materials in the bottle industry are approximately as shown below:—

TABLE XIII.

	Indian	English.	Belgian.	German.
Sand	23	27	9	19
Soda ash	67	61	87	79
Lime	10	12	...	...
or				
Limestone	...	...	4	8
	100	100	100	100

The percentage of the cost of soda ash per unit of glass varies so widely according to the location of the factory and to some extent also according to the kind of glassware made that it is almost impossible to estimate definitely the relative importance of soda ash in the manufacture of glass in India. Where a factory is situated at a distance from the sand deposits, the higher cost of sand will reduce the proportion borne by the cost of soda ash. On the other hand, if a factory is located inland, the freight on soda ash from the port will raise its cost proportionately. We find, for example, that in factories situated near Bombay, the cost of soda ash is generally not more than 30 per cent. of the total cost of materials, while in factories situated in Calcutta it is 40 to 45 per cent. and in the United Provinces it is as high as 70 to 75 per cent. It would be entirely misleading to infer from this that the factories in Bombay were more favourably situated in respect of natural advantages. Sand is generally obtained in Bombay from the deposits in the United Provinces and the freight adds so considerably to the cost of sand as to raise it proportionately to that of other materials. Naturally the cost of soda ash is relatively highest in the United Provinces where the sand is the least expensive. That the percentage cost of soda ash is a misleading test of the importance of its presence in the country as a natural advantage is further evident when we examine it in relation to the total cost of production. It is again in factories on the Bombay side that the proportion is lowest, generally not exceeding 10 per cent. In Calcutta it approximates to 15 per cent. while in the United Provinces it ranges from 20 to 25 per cent. The United Provinces factories have the advantages of cheap sand and of low labour costs which result in a higher proportionate cost of soda ash. On the Bombay side both sand and coal are considerably more expensive and labour costs higher with the result that the cost of soda ash is lower in proportion. In attempting to determine the relative importance of soda ash by the test of percentage cost, it is easy to overlook the fact that the proportionate cost of soda ash is chiefly determined by the other elements in the cost. It is variation in these elements rather than in the cost of soda ash which largely accounts for the differences in the percentage cost of the latter.

41. That India pays more for its soda ash than glass manufacturing countries in Europe cannot be denied. At the same time India has considerable compensating advantages which should be taken into account in estimating the position of the industry in regard to the claim to protection. The following table exhibits in approximate figures the percentage costs under 'materials', 'Power and Fuel' and 'Labour' in sheet glass factories in India and in other countries using the same process:—

High cost of soda ash in India.

TABLE XIV.

	Indian.	Belgian.	American.	German.
Soda ash and salt cake	28	20	15	16
Other materials including packing	22	27	22	20
Power and fuel	33	21	13	24
Wages and salaries	17	32	50	40
	100	100	100	100

The position in respect of blownware made entirely or mainly by hand is illustrated by the following table:—

TABLE XV.

	Indian.	German.	American
Soda ash	19	13	6
Other materials	15	14	23
Power and fuel	18	14	6
Wages and salaries	48	59	65
	100	100	100

The large proportion of the cost of soda ash in Indian factories is partly due to the much higher rate of import duty in force in India and in the case of blownware is partly due also to the excessive use of soda ash in Indian factories. If the duty is reduced to the normal rate and if, as we have suggested in this report, Indian factories reduce their consumption of soda ash, the proportionate cost would not be so high.*

42. We have shown that the proportion borne by the cost of soda ash to the total cost does not by itself afford a correct indication of its relative importance in the manufacture of glass in India and that in determining the position of the Indian industry as compared with that of other countries, it is necessary

Claim to protection not invalidated.

* The high cost of fuel in Indian factories as shown in the statements is to be attributed mainly to the excessive consumption of coal due to the provision of inadequate furnace arrangements. If our suggestions in this respect are carried out by the factories, a large reduction may be expected.

to consider the extent to which the disadvantages in respect of soda ash is counterbalanced by advantages in other respects. We have already explained the favourable position which the Indian industry holds as regards supplies of sand, and we shall show later that it possesses also considerable advantages in other respects, such as fuel, labour and extent of market. Whether the sum total of these advantages is sufficient to offset the disability resulting from imported soda ash can only be determined by an examination of the future costs of the industry. We reserve the question of costs for detailed examination in the next chapter. Meanwhile it may be stated that the estimates of costs set forth in that chapter support the conclusion that if reasonable improvements are effected in equipment and processes of manufacture and if a larger output can be secured, the Indian glass industry will be able eventually to meet foreign competition unaided. In these estimates the cost of soda ash is taken at the price at which it is now imported into India. If at this price of soda ash the Indian glass industry may be expected ultimately to dispense with protection, it necessarily follows that the handicap imposed on the industry by its having to import soda ash is sufficiently balanced by the advantages which it possesses in other respects. On this view of the case, we hold that the fact that the Indian glass industry is now dependent on imported soda ash does not invalidate the claim to protection, especially when there is a reasonable prospect that the manufacture of the material in India will be resumed almost immediately.

Lime.

43. In addition to sodium oxide, a second basic oxide is needed to give stability and resistance to glass. For this purpose manufacturers of glass in India employ calcium oxide, of which in the form of calcium carbonate (limestone) abundant supplies are available. Calcium oxide may be introduced into glass mixtures either in the form of limestone, or in that of quick lime, obtained by applying strong heat to limestone, or in that of slaked lime which is obtained by bringing quick lime into contact with water. Pure quick lime contains 100 per cent. calcium oxide; slaked lime 75·7 per cent. and limestone 56 per cent. The impurities which may be contained in the limestone are not removed by converting limestone into quick lime; and quick lime and to a lesser extent slaked lime, are liable to rapid change of composition when exposed to the atmosphere. They are therefore not so suitable for use in glass manufacture, where it is necessary to know the exact composition of the material at the time of use, as limestone which does not change its composition in storage. However, under certain conditions, and particularly for glass melted in pots, quick lime and slaked lime may show to advantage over limestone when the rate of melting is considered. It is therefore necessary for the glass manufacturer to determine whether the advantages obtained by the increased rate of melting compensate for the cost of calcination and for the loss of constancy in composition. The impurities most commonly found in limestone are iron oxide, alumina, magnesia and silica; and, as in the case of sand, it is iron oxide which is the

most deleterious to glass; but as limestone generally constitutes less than one-fifth of the glass batch the presence of iron oxide in the limestone does not have so marked an effect on the glass as the same percentage present in the sand. Limestone used in the manufacture of 'white' glass should contain less than 0·15 per cent. of iron oxide and for pale green glass the iron oxide content should be less than 0·3 per cent.

Limestone deposits in India.

44. Supplies of limestone can be obtained almost anywhere in India. Dr. L. L. Fermor of the Geological Survey of India in the Indian Munitions Board's Industrial Handbook (pages 232-233) has given analyses of limestone from about 40 different places. From the glass manufacturers' point of view it is unfortunate that none of these analyses give the iron oxide content of the limestone separately from that of alumina. One of the glass works has given us an analysis of limestone from Katni, where the supplies are said to be "practically inexhaustible, composition somewhat variable in different places but uniform locally", which compares not unfavourably with analyses of English limestones:—

TABLE XVI.

—	CaO.	MgO.	Al_2O_3.	SiO_2.	Fe_2O_3.	P_2O_5.	SO_3.	CO_2.	H_2O.	Loss on ignition.	$CaCO_3$ + $MgCO_3$.
Katni .	60·40	2·82	0·72	3·85	0·32	0·03	0·50	3·92	18·24	..	92·84
English.											
1	55·00	0·7	0·4	0·2	0·03	..	..	..	..	43·7	99·4
2	52·78	0·20	0·03	..	0·03	..	..	..	..	41·62	94·60
3	54·93	0·24	0·10	..	0·75	..	..	..	..	42·56	97·75
4	54·80	0·11	0·69	..	0·16	..	..	..	..	42·88	97·79

There can be little doubt that with reasonable care in the selection of supplies free from high percentages of impurities, the glass factories can obtain as much limestone as they need of the best quality. The price too is low; we are informed that the present cost of limestone at Katni is 6·5 annas a maund or about Rs. 11 a ton f.o.r.; and one factory states that it can get supplies from Maihar in Central India at a f.o.r. price of 1·66 annas a maund or less than Rs. 3 a ton.

Other materials :— Zinc oxide.

45. The only other basic oxide used by glass manufacturers in India is zinc oxide. Its use in India is confined to the bangle industry and to the making of selenium red glass. In ordinary practice the proportion of zinc oxide should seldom exceed 5 parts to every 100 parts of sand. But one maker of bangles who

has given particulars of his composition uses such a large proportion of soda ash that he adds 12 parts of zinc oxide for every 100 parts of sand. This of course adds greatly to the cost of his glass. Zinc oxide is not obtainable in India and is imported from abroad.

Saltpetre.

46. The oxidising agent commonly used in Indian glass works is potassium nitrate or saltpetre. There are supplies of this material in Bihar, where it has for many years been collected for export, and manufacturers have no difficulty in obtaining it in the country.

Zinc dust.

47. Zinc dust is used as a reducing agent in some bangle factories to produce the conditions necessary for the formation of selenium red glass. It is not obtainable in India and is imported.

Colouring materials

48. The colouring agents most frequently used are cadmium sulphide and selenium: others used by Indian manufacturers are the oxides of cobalt, copper and uranium. Manganese dioxide is used as a decolouriser in pots, and in tank furnaces the decolourisers used are selenium, cobalt oxide and arsenious oxide. Great care is needed in using these materials to see that the principal raw materials are as free as possible from impurities, that the temperature of the furnace is high and constant, and that the glass batch is placed in the furnace at regular intervals and in regular quantities; but with proper attention to these matters the decolourising materials can be very effective. The only colouring agent which is now produced in India is manganese dioxide. The rest are imported. Though the quantities of the various colouring agents used are small, the cost of these chemicals is so high that in the bangle industry it forms a very considerable proportion of the cost of the raw materials and of the total cost of production. In one bangle factory the cost of the colouring agents amounts to 45·75 per cent. of the total works costs; in this factory the cost of these agents is as much as 73·30 per cent. of the cost of the raw materials. In other bangle factories the colouring agents represent 44·12 and 41·68 per cent. of the total cost of raw materials, or 15·52 and 3·13 per cent. of the total works costs. These figures point to the need for investigation whether suitable colouring materials cannot be obtained in India or manufactured from materials available in the country. At present the most costly ingredient, selenium, is obtainable directly only in America. The high proportion of the cost of colouring materials in the Indian bangle industry is sufficiently counterbalanced by advantages in other respects, particularly the cost of labour and the fact that India constitutes practically the whole market in the world for glass bangles. As we show in Chapter III, but for the prejudice which exists in the market against Indian bangles, even now the industry would be able to dispense with protection.

Refractory Materials.

49. So far we have considered the various raw materials which may be required for the composition of the glass batch. This batch has to be melted in a furnace the temperature of which may have to be as high

as 1,450° C.; even higher temperatures may be required in the manufacture of special classes of glassware which are not now made in India. It is of supreme importance to the glass industry to secure refractory materials of suitable quality; for upon these depends in large measure the life of the furnace, the life of the pots, the quality of the glass and the consumption of fuel. It is therefore important that the manufacturer of glass should be able to specify exactly what he requires and that the manufacturer of the refractories should be in a position to supply materials to meet the specifications. The chief refractory materials required by the manufacturer of glass are made from fireclays or silica and to some extent from bauxite, sillimanite and cyanite. Since glass tends to be acidic rather than basic in character, such basic refractories as lime or magnesia cannot be used; but glass is not sufficiently acidic to be allowed direct contact with such highly siliceous products as silica bricks, the use of which must be confined to parts of the furnace where the glass will not come into direct contact with them. Fireclays in general are neither acidic nor basic and are therefore employed in contact with glass.

Chemical Composition of Indian fireclays.

60. The qualities which must be investigated in determining the value of refractory materials are their density, porosity, expansion or contraction on exposure to change of temperature, mechanical strength and heat conductivity. These qualities depend partly on the chemical composition of the materials and partly on their physical condition. It is therefore necessary in judging the suitability of refractory materials for use in glass furnaces to know both their chemical and their physical properties. The chemical analysis of clay is also important as an indication of the presence of impurities. Clay is the product of the decomposition of rock and may contain any or all of the impurities present in the original rock. A pure felspar would decompose into a pure clay composed of silica, alumina and water. But most clays contain also such impurities as titania, lime, magnesia, iron oxide, potash, soda, carbonaceous and other matter. It is only by chemical analysis that the presence of impurities can be detected and the suitability of the clay for use in glass works determined. We have already seen that the presence of iron oxide is harmful to glass; and as attack by glass may cause solution of clay in the glass, a clay containing a high percentage of iron oxide should not be used. Lime, magnesia, potash and soda increase the fluxing tendencies of the clay and should not be present in large quantities. The following table shows the chemical analyses of Indian fireclays and firebricks together with those of English clays and the famous German Grossalmerode clay. The analyses of the firebricks may not be strictly comparable with those of the clays; but they serve to indicate the nature and quantities of the impurities present. Some of the Indian analyses are not complete.—

TABLE XVII.

Chemical Analyses of Fireclays and Firebricks.

—		SiO_2.	Al_2O_3.	Fe_2O_3.	TiO_2.	CaO	MgO.	K_2O.	Na_2O.	Total Oxides.	Loss on ignition.
English clay	1	52·12	41·11	2·81	1·37	0·53	trace.	0·98	1·07	86·67	13·27
	2	53·79	38·86	2·80	1·64	0·47	0·28	2·07	0·07	85·83	14·43
	3	64·13	29·73	2·60	1·57	trace	trace	1·20	0·77	90·60	9·68
	4	64·34	29·47	2·67	1·33	0·27	0·51	1·18	0·20	89·98	10·34
	5	71·90	22·54	2·59	1·17	0·17	0·49	0·72	0·42	93·26	7·26
	6	75·60	19·26	2·30	1·27	0·13	0·40	0·89	0·16	93·06	7·35
	7	63·65	29·49	3·40	1·12	0·24	0·66	1·21	0·31	90·90	9·49
	8	74·35	19·02	3·56	1·17	0·25	0·54	1·00	0·12	93·25	6·97
	9	54·25	37·15	2·88	1·48	0·42	0·99	2·83	trace	89·11	10·77
	10	55·64	35·55	4·67	1·81	0·20	0·44	1·24	0·45	88·90	11·52
	11	68·83	27·04	1·60	1·39	0·22	0·33	0·60	trace	91·00	9·20
	12	66·64	28·02	1·83	1·41	0·38	0·55	1·13	0·04	90·94	9·45
	13	56·52	36·61	2·71	1·54	0·32	0·54	1·67	0·09	85·36	14·96
	14	73·58	21·70	1·39	1·43	0·34	0·29	0·85	0·41	23·04	7·51
Gromalmerode clay		75·26	19·09	1·70	2·00	0·44	0·36	0·77	0·17	93·91	6·24
Indian Clays.											
Raw clay	1	69·35	27·87	1·19	-	0·63	0·32	0·64		90·73	9·35
	2	71·31	24·40	1·50	1·52	*Nil*	0·62	0·65		92·00	7·95
	3	66·56	28·28	1·28	1·58	0·44	0·59	1·27		92·56	7·29

—		SiO_2.	Al_2O_3.	Fe_2O_3.	TiO_2.	CaO	MgO.	K_2O.	Na_2O.	Total Oxides.	Loss on ignition.
Indian Clays.											
Raw clay . . .	4	69·74	28·21	0·83	0·53	0·31	0·38	..	..	90·78	8·97
	5	67·26	30·26	0·90	0·60	0·59	0·39	..	..	90·63	9·82
Calcined clay . . .	1	68·60	28·86	0·88	..	0·68	0·50	0·57			
	2	69·50	28·11	0·82	0·53	0·31	0·37			..	0·20
	3	67·42	30·33	0·91	0·60	0·60	0·39	..	..	..	..
Firebrick . . .	1	69·92	26·94	1·04	..	0·80	0·46	0·51	0·20	..	..
	2	69·20	28·21	1·20	..	0·60	0·24	0·36	0·14	..	..
	3	66·36	31 25	0·69	0·48	0·54	0·36	..	..	..	..
	4	56·04	39·52	3·12	..	0·10	0·10	1·20	0·38	..	0·20
	5	58·84	36·46	3 30	..	trace	0·22	1·66	0·06	..	..
	6	62·54	32·32	3·28	..	0·22	0·10	1·80		..	..

English and German clay analyses from Journal of the Society of Glass Technology 1920, 4, 169.
Indian raw and calcined clays and Firebricks 1, 2, 3 from Messrs. Burn and Company, Jubbulpore.
Firebricks 4, 5, 6 from Messrs. Bird and Company, Kumardhubi.

The Indian clays compare very favourably with the English and German clays. The iron oxide content in the case of the Jubbulpore clays is markedly low, and so also are the proportions of the fluxing impurities. The analyses indicate that the Indian clays are eminently suitable for the manufacture of glass furnace refractories. It is true that the specification for tank block and pot clays suggested by the English Society of Glass Technology requires a higher proportion of alumina to silica than the Indian clays show; but many of the English clays also fail to meet this specification, and for pot making some manufacturers prefer the higher silica content. Several Indian glass manufacturers are in fact making their own pots and crucibles from Jubbulpore clay mixed with grog obtained from used pots. Though the experimental stage has hardly been passed, it does appear that the home made pots are cheaper and more durable than those imported from Japan and that the clay is quite suitable for this purpose. The fact that the life of pots in India is not so long as it is in England is due mainly to the wide variations of temperature to which they are subjected in the Indian direct fired furnaces.

Physical properties of Indian fireclays.

51. The available information regarding the physical properties of the fireclay goods made in India is scanty. The clay after weathering is sufficiently plastic for pot and tank block manufacture and enables a satisfactorily high grog content to be attained. The density of the materials is expressed as a proportion of the weight of an equal volume of water taken as unity. The average density of English clay materials after firing at 1,400° C. is about 2·50; that of a brick made from Jubbulpore clay is 2·52, or almost identical with that of English clays. The porosity of bricks is expressed as the percentage borne by the hollow parts of the brick to its total volume. Firebricks and tank blocks usually have a porosity between 20 per cent. and 30 per cent. The porosity of bricks made at Kumardhubi has been ascertained to be 29·1 per cent., 26·0 per cent. and 20·5 per cent. The refractoriness of the clays mentioned in Table XVII, or the temperature at which the clays soften, has been ascertained to be between 1,650° and 1,670° C.—which is a satisfactory figure. Thus the fireclays now being used in India reach the chemical and physical standards of the English materials, and we are satisfied that goods of the requisite quality can be made from Indian fireclay. Any complaints by glass manufacturers are caused by their failure to see that the goods which they buy are of the best quality, and by their allowing themselves to be persuaded by immediate financial considerations to purchase inferior materials.

Silica bricks.

52. Silica bricks of excellent quality are obtainable and find general use for furnace crowns. Analyses are given of the saccharoidal quartzite from which they are made and of two typical bricks.

TABLE XVIII.

Analyses of Quartzite and Silica Bricks (Kumardhubi).*

	Quartzite.	Silica Bricks. A.	Silica Bricks. B
SiO_2	98·12	95·26	95·60
Al_2O_3	0·60	0·87	0·76
Fe_2O_3	0·42	0·45	0·68
CaO	0·21	2·26	1·92
MgO	0·12	0·25	0·25
Alkalies	0·50	0·86	0·65
	99·97	99·95	99·86
Porosity		19·7%	22·6%
Specific gravity (powder)	...	2·338	2·365

'Mullite' refractories.

53. The presence in India of deposits of cyanite and sillimanite, the raw materials required for the manufacture of what may be termed Mullite refractories, places this country in an exceptionally favourable position for the development of their use. There are deposits of cyanite in Singhbum (Bihar and Orissa) and of sillimanite in Assam and in Rewa State. The exploitation of these deposits may enable India to take a leading part in the production of the so-called 'Super-refractories', and incidentally to benefit her own glass industry.

Coal :— Calorific value of Indian Coal

54. Coal is used in Indian glass factories to heat the furnaces. In most cases the coal is applied directly; but in a few of the better equipped factories the heat is produced in the furnace by the use of producer gas which is generated from coal. Heat is also needed at the 'glory-holes', in the annealing process, and for other operations such as the joining of bangles, and the finishing of lamp chimneys and globes. Wood is occasionally used to provide the heat required for the annealing process. For the various finishing processes some factories use gas, which is either obtained from a public supply or generated from petrol, and some of the smaller bangle factories obtain the heat required to join the bangles from the flames of oil lamps. But in all the factories the principal fuel is coal; and it is therefore necessary to ascertain how far the sort of coal which can be obtained in India has the qualities necessary to meet the requirements of a glass works. For this purpose it will be useful to see how it compares with the coal commonly used in modern glass furnaces in England. Since coal is used for the sole purpose of producing heat, the ultimate criterion of its value must be the amount of heat which it gives out when burned, or its calorific value; this

* From Messrs. Bird and Company, Kumardhubi.

depends upon its composition and upon its comparative freedom from ash and moisture. When the ash and moisture contents are high, the manufacturer is paying for a considerable proportion of material which is not only useless, but which may also prevent him from obtaining the maximum heating value from the rest of the coal. Other factors to be considered in estimating the value of a particular coal are its coking or non-coking properties, the nature of the flame which it produces, the composition of the ash, and of course the cost. Practically all the Indian glass factories use Bengal coal; we have been told that considerations of freight have led one or two of the factories in the Bombay Presidency to try coal from the Central Provinces, but that the saving on freight did not make up for the inferiority of the quality of the coal. We shall therefore confine our attention to the coal obtained from the Jharia and Raniganj coalfields. From a very large number of analyses made at the Government Test House either for the Indian Coal Grading Board or for suppliers of coal we have arrived at the following average compositions for the two fields:—

TABLE XIX.

	Volatiles.	Fixed Carbon.	Ash.	Moisture.
Jharia	23·5	63·0	13·5	1·5
Raniganj	32·0	55·0	13·0	4·0

and we compare with these the following analyses of various coal which has been regularly used in glass works in England:—

TABLE XX.

Analyses of English Coals.

	Volatiles.	Fixed Carbon.	Ash.	Moisture.
A. Rough or Slack .	30·58	57·65	11·77	6·5
B. Washed Coals—				
1.	35·99	59·54	4·47	8·23
2.	35·16	60·98	3·86	8·29
3. . . .	31·25	61·99	6·76	4·27
4. . . .	37·17	58·30	4·53	10·80
5.	35·05	62·28	2·67	3·13

We note that the ash content of Indian coal is generally higher than that of English coal while in respect of moisture the Indian coal generally has the advantage. But the ash and moisture content owe their chief importance to the effect which they produce upon the calorific value of the coal. The calorific power of a fuel is defined as "the number of units of heat produced by the complete combustion of unit weight of the fuel". Thus a coal is said to have a calorific value of 13,000 B. T. U. (British Thermal Units) when one pound of coal on complete combustion

produces enough heat to raise the temperature of 13,000 lbs. of water 1° F. Since the economic value of coal to a manufacturer must depend upon the relation between its calorific value and its cost, we have formed an estimate of the average calorific value per anna of cost for average Indian and English coals. After making allowance for freight in the one case to Calcutta and in the other case to London, for loss in transhipment between the colliery and the factory (8 per cent. in India and 1 per cent. in England), and for moisture, the average works out to 185,000 B. T. U. per anna for Indian coal (Jharia 185,300 and Raniganj 184,200) and 100,940 B. T. U. per anna for English coal. The difference is mainly due to the greater cost of English coal in London as compared with that of Indian coal in Calcutta and to a small extent to the lower moisture content of the Indian coal. The advantage of the Indian coal in these respects is however partly discounted by its higher ash content, which affects its burning qualities and creates difficulties in stoking. Further, since the principal glass factories are located not in Calcutta, but in the United Provinces, the freight charges payable by the factories will generally exceed those to Calcutta, and so the value of the coal per unit of cost will be reduced. The following table shows how the heating value of coal per unit of cost declines as the price per ton is raised by higher freight charges.

TABLE XXI.

Comparative Coal Values.

	Price per ton.	Freight.*	Distance from coal-field (approx.).	B. T. U. per anna.
	Rs.	Rs. A. P.	Miles.	
Calcutta	9	4 5 0	150	185,000
	10			166,500
Allahabad	11	6 3 0	350	151,400
Firozabad	12	8 0 0	700	138,800
Bahjoi	13	8 5 0	700	128,100
	14			118,900
Ambala	15	9 8 0	1,000	111,000
	16			104,100
	17			98,000
Paisa Fund	18	12 4 0	1,250	92,500
	19			87,600
Ogale-Kandivle	20	15 6 11	1,350—1,500	83,300

The factories in the United Provinces can still get their coal at a relatively cheaper price than factories in London; but by the time the coal has been transported to Bombay, all the initial advantage has been swallowed up by higher freight charges; the coal is relatively more expensive than in London and it has still

* These rates do not include the 15 per cent. surcharge recently imposed.

to bear the handicap of the higher ash content. Moreover, the greater the distance the coal has to be transported the greater the risks of loss on the way, and an allowance of 8 per cent. would probably not be sufficient to cover the loss of coal between the colliery and Bombay. Up to a distance of about 1,000 miles from the coalfields the lower cost and the lower moisture content of Indian coal give it an advantage when compared with English coal, in spite of its lower calorific value and its higher ash content. The factory at Ambala is on the border line, and the glass works in the Bombay Presidency owing to the higher freight charges are at a disadvantage compared with factories in England.

Other qualities of Indian coal.

55. In other respects also Indian coal bears comparison with representative English coal. The composition of the ash is important because fusibility in the ash, which increases with the proportions of calcium, magnesium and iron oxides to those of alumina and silica, causes clinkering which adds to the stoker's labour, blocks the fire, causes blow holes by which cold air may be admitted, the heating value of gas reduced and damage caused to pots, and may also lead to injury to the furnace bars and firebox refractories. The following Table shows the composition of the ash contents of a few Indian coals as compared with some typical English coals:—

TABLE XXII.

Compositions of Coal ash.*

—	SiO_2.	Fe_2O_3.	Al_2O_3.	TiO_2.	CaO.	MgO.	Na_2O. K_2O.	SO_3.	P_2O_5.
Dibrugarh . . .	40·40	6·68	28·14	1·20	7·90	2·35	0·85	2·95	3·78
Pondati	46·40	13·32	21·76	1·10	7·90	1·65	1·56	2·84	3·58
1st Class Jharia . .	60·05	8·68	26·93	1·20	0·40	0·62	0·90	0·92	0·10
1st Class Raniganj . .	60·20	6·05	25·17	1·20	2·70	1·56	1·17	0·66	1·58
Selected Jharia . . .	49·75	5·93	35·47	1·30	2·10	1·38	3·25	0·35	0·20
English . . .	24·46	27·46	19·02	0·86	9·39	4·70	2·86	7·35	..
	42·86	16·16	31·63	1·55	4·05	0·85	2·02	1·26	..
	43·98	14·70	30·37	1·19	1·28	1·18	5·76	1·20	..
	48·30	9·29	31·35	2·77	1·93	2·13	2·48	1·60	..
	48·94	2·10	30·77	1·36	4·94	0·61	2·11	2·14	..

It is clear that the Indian coals do not suffer by this comparison. As regards coking properties, glass furnaces in general require a

* The figures for the Indian coals were supplied by the Indian Coal Grading Board whilst those for English coals were selected from a number published in the Fuel Research Technical Paper No. 23, Department of Scientific and Industrial Research, London, 1929.

coal which cokes partially, not one which gives a powdery coke, nor one which forms dense hard coke. The majority of Indian coals are of this medium variety, and therefore suitable in this respect for use in glass furnaces. When coal is used for direct firing, or in furnaces with internal gas producers, it should be of the 'long-flame' variety and burn readily. Indian coal generally is of this description and is therefore suitable for use in such conditions.

Coal and oil fuel compared.

56. Our conclusion is that the availability of supplies of coal in India constitutes an advantage for the glass industry. In its lower calorific value and higher ash content Indian coal suffers by comparison with English coal; but so far as most of the glass works in India are concerned these disadvantages are outweighed by the lower cost and the lower moisture content of Indian coal. Factories situated in the Bombay Presidency do not share in this advantage; and it might be worth their while to investigate the possibility of adopting the use of oil fuel instead of coal in their furnaces. The calorific power of oil is about 50 per cent. higher than that of coal and it is more uniform in composition; it requires less labour and storage room; it is cleaner, handier, more adaptable and easier to control. But its greatest advantage over coal is that a much higher proportion of its heating value can actually be used to melt the glass than is the case with coal; even in the best gas fired furnace not more than 15 per cent. of the heating value of the fuel is actually used in melting the glass, whereas with oil the efficiency may reach 30 per cent. On the other hand the relative cost of oil is higher, and in an oil fired furnace the wear and tear of refractories is somewhat greater than in one fired by coal or gas. Moreover, oil is not so suitable for a pot furnace as for tank furnace firing. At current prices the calorific value of coal per anna of cost at Bombay is 83,250 B. T. U. as compared with 82,222 for oil; and when the greater efficiency of oil firing is considered, it is evident that the question of adopting oil fuel deserves investigation by manufacturers in the Bombay Presidency.

Labour.

57. The glass industry may be said to enjoy two special advantages in regard to labour. The first is that most of the factories are situated in the United Provinces where labour is available in abundance at far lower rates than those which obtain in such large industrial centres as Calcutta and Bombay. While factories in the United Provinces can get as much unskilled labour as they need at rates which vary from 4½ annas a day at Bahjoi to 6 annas a day at Naini, the current rate of wages in Bombay and Calcutta is nearly double. The second advantage is the existence at Firozabad of a special class of Muslims known as 'Shishgars' (glass-makers) who have been engaged in the bangle industry for centuries, the art having been handed down from father to son for many generations. Not only do these people carry on the manufacture of bangles by the primitive method in which they have hereditary skill: but they

have shown themselves capable of adopting modern methods with a considerable measure of success.

Former defects of labour in Indian glass factories.

58. The Indian Industrial Commission in paragraph 7 of its note on the Manufacture of Glass in India (Appendix E to the Report) commented on certain defects which were then apparent in the labour employed in glass factories in India. And Sir Alfred Chatterton in his Chapter on the manufacture of glass in India in the Indian Munitions Board Handbook repeats these criticisms in the following terms; "It is true that a considerable number of men have been trained in the last few years by the Austrians and Japanese who were brought out to India in connection with the pioneer efforts to which reference has already been made. Useful work has been done by the Paisa Fund at the Talegaon Glass Works in training glass blowers, and the expansion of the industry under war conditions is chiefly due to the supply of men who have come from this place; but the men are not well trained and the inferior quality of Indian glassware is partly due to this fact. There are however signs of progress under the pressure of war demands, and this is satisfactory as furnishing evidence that a well devised scheme for the training of glass workers will meet with success. During the war it was easier to find capital than labour, and the managers of every factory have complained of the shortage of skilled men and the difficulty in training fresh hands. At present the glass blower dominates the situation and though he earns very high wages there is much friction between the manager and the men. The glass industry has come to stay; but without aid from the State it is likely to make very slow progress in the future. Adequate arrangements are necessary to provide for the thorough training of glass blowers and men to work glass blowing machinery . . . . it seems desirable that the next step in developing the glass industry should be taken by Government and should consist in establishing a glass factory equipped with an efficient technological laboratory and provided with a competent staff of experts and skilled glass workers."

Present condition of labour in the glass industry.

59. Thus at the close of the war, the difficulties facing the glass industry in connection with labour were its scarcity and its lack of technical skill. The position to-day is different. In spite of the increase in the number of factories there are no complaints now of shortage of labour, the industry is no longer at the mercy of the glass blower and we have heard of no friction between masters and men. Nor does it appear that the skill of the Indian glass blower and the artisans is so markedly inferior as to constitute a handicap to the Indian industry. At present a skilled workman has little incentive to keep his work up to a high standard. All the Indian factories attach far too little importance to the quality of their products; and when the management will pass work of any quality, the workman naturally thinks

that anything will do. Another incentive to good work which we have found in only one factory in India is the payment of wages at piece work rates with insistence upon quality before payment; an extension of this system would certainly improve the quality of the work turned out. From the work which we have seen in the different factories which we have visited we have formed the opinion that the inferior quality of much of the glassware made is due not so much to lack of skill on the part of the workman as to lack of organising ability on the part of the management. The skill displayed for example, by the man who in the manufacture of bangles manipulates the glass which is being wound on to a roller in the form of a spiral, is of a high order. Most of the Austrians and Japanese, from whom in the main the Indian industry acquired a knowledge of its present methods, have now disappeared. One of the new bangle factories employs two Japanese artisans; and in the Allahabad Glass Works there is an English foreman in charge of the machines,[4] an Austrian glass blower and a Japanese. On the other hand, the Fourcault sheet glass machines at the United Provinces Glass Works are entirely in the charge of Indians. For some time after their erection, Belgians were retained to supervise their working; but the last of the Belgians was sent home about 18 months ago; and since then the machines have been operated successfully without their assistance. We see no reason why what has been done in this case should not be achieved in other factories; it should not be necessary to retain the services of European, Japanese or American labour either on the machinery or on the manipulation of glass longer than the period required to train Indians to do the work.

Market: Imports.

60. The value of the glassware imported into India in each of the last five years is shown in the following table:—

TABLE XXIII.

Articles.	Value in lakhs of rupees.				
	1926-27	1927-28.	1928-29.	1929-30.	1930-31.
Bangles	84·86	89·52	76·70	85·23	49·90
Beads and false pearls	36·95	26·62	30·42	30·61	15·72
Bottles and phials	39·94	33·01	36·19	39·49	29·04
Lampware	19·37	22·20	19·58	21·08	12·96
Scientific glassware	2·32	1·73	1·66	1·34	1·43
Sheet and plate glass	31·66	29·86	20·68	30·97	23·88
Tableware	9·15	9·40	10·94	13·29	9·46
Other glassware	35·34	36·06	32·26	29·98	22·19
TOTAL	259·59	248·40	227·40	251·98	164·78

The above table reproduces the values shown in the Trade Returns under glassware. There are, however, at least two kinds of glassware which are not included under this head: electric light bulbs are included under Instruments and have only been shown separately in the Trade Returns since April 1931; in the 9 months April to December 1931, the value of the imports under this head is recorded as Rs. 28 lakhs; but this figure presumably includes the value of the metal fittings as well as the glass in the bulbs. Glass tiles are included under Building Materials and are not shown separately even now. In 1913-14, the year before the war, the value of the glassware imported was Rs. 194·53 lakhs. The effects of the outbreak of the war are shown by the fall of the value of glass imported in 1914-15 to Rs. 96·53 lakhs; and the increase in the value of the imports in the later war years represents an increase in price rather than in quantity. Immediately after the war there was an enormous increase, the value of the imports in 1920-21 reaching Rs. 337·62 lakhs. And in recent years up to the depression which is reflected in the figures for 1930-31, the value of the imports has remained on the average round about Rs. 2¼ crores. Nor has there been any marked variation between the years 1926-27, and 1929-30 in the value of the various kinds of glass imported. Compared with the figures for 1926-27 the principal variations in those for 1929-30 are increases of Rs. 4·14 lakhs in the case of tableware and Rs. 1·71 lakhs in the case of lampware; and decreases of Rs. 5·62 lakhs in the case of other glassware, Rs. 0·98 lakhs in the case of scientific glassware and Rs. 0·69 lakh in the case of sheet and plate glass. The Trade Returns show the quantity as well as the value of the imports in the case of beads and false pearls, bottles and sheet and plate glass and an examination of these figures indicates that there has been a greater increase in the quantity of goods imported than is suggested by a study of the values alone. Thus in the case of beads and false pearls, while the quantity imported in 1929-30 was 6·4 per cent. in excess of that imported in 1925-26 the value of the imports in 1929-30 was 16·1 per cent. less than that of the imports in 1925-26; and in the case of bottles, while the quantity imported in 1929-30 was 30·9 per cent. in excess of the imports in 1925-26, the value of the imports in the later year was only 4·8 per cent. in excess. On the other hand the quantity of sheet and plate glass imported has remained fairly constant, while there has been an increase in their value by about 10 per cent. Of the total value of the glass and glassware imported in 1929-30, 29·4 per cent. came from Japan, 28·4 per cent. from Czechoslovakia, 13·6 per cent. from Germany, 9·5 per cent. from the British Empire and 9·4 per cent. from Belgium. Since 1925-26 Japan has gained appreciably in the Indian market at the expense of Czechoslovakia, Germany and the British Empire. The following Table shows for each class of glassware recognised by the Trade Returns the percentage of the total value of the imports which came to India in 1929-30 from each of the principal exporting countries:—

TABLE XXIV.

Percentage of value of each kind of glassware imported into India in 1929-30.

—	Czechoslovakia.	Japan.	Italy.	Germany.	British Empire.	United States of America.	Austria.	Belgium.	Others.
Bangles	65·4	29·3	..	2·0	..	..	·9	..	2·4
Beads and false pearls	37·1	30·5	18·2	5·7	..	..	5·1	..	3·4
Bottles—									
Sodawater bottles	..	..	..	46·8	46·3	..	..	..	6·9
Other bottles and phials	..	55·8	..	20·4	16·1	..	..	..	7·7
Lampware	5·6	11·2	..	44·8	..	21·3	8·4	6·5	2·2
Scientific glassware	..	9·2	..	56·6	25·9	..	..	..	8·3
Sheet and plate	6·2	5·4	..	5·0	16·2	..	..	60·5	6·7
Tableware	2·1	68·0	.	8·7	7·0	..	..	11·4	2·8
Other kinds	..	43·4	..	19·1	18·1	..	..	6·6	12·8
All sorts	28·4	29·4	2·2	13·6	9·5	1·8	1·6	9·4	4·1

Indian manufactures.

61. Sir Alfred Chatterton in 1919 estimated the value of the glassware made in India at roughly one fourth of the value of imported glassware. The value of the imports in 1917-18 was Rs. 162 lakhs; and his estimate of the value of the glass made in India was approximately Rs. 40 lakhs of which Rs. 20 lakhs represented the glass bangle trade of Firozabad. We have seen that the average value of the imports of glass between 1925-26 and 1929-30 was about Rs. 250 lakhs a year; so if the proportion of manufactured goods to imported has remained constant, the value of the glass manufactured in India should now be about Rs. 60 lakhs a year. The Allahabad Glass Works have in fact estimated the value of Indian manufactures to-day at Rs. 60 or Rs. 70 lakhs a year, while the Ogale Glass Works indicate Rs. 50 lakhs as the present value of the glassware made in India. On the other hand the Glass and Bangles Industrial Association of Firozabad estimate the value of the outturn of bangles alone in the various factories at Firozabad at Rs. 115 lakhs a year. We have already referred to the great expansion of the bangle industry which has taken place at Firozabad since 1925; and we consider it

possible that the annual outturn of bangles there may not be far short of the figure given by the Association. But we cannot regard these figures otherwise than as approximations: no statistics of production are compiled or published; and the manufacturers have not been able to give us precise information regarding their production. Consequently we are not in a position to frame more than a very rough estimate of the quantity or value of the glassware manufactured in India to-day. With regard to certain kinds of glassware however we have been able to form more definite opinions. Sheet glass is at present made in only one factory and we have ascertained that the actual outturn of this factory in 1930 was approximately 30,000 boxes of 100 sq. ft. each or a total of 30,00,000 sq. ft. as compared with approximately 2,20,00,000 sq. ft. of plate and sheet glass imported of which we may assume that about 1,40,00,000 sq. ft. were sheet glass. Similarly in respect of bottles and phials we have been informed of the output of five out of the twelve factories in which they are made; and making allowance for the products of the other small factories from which we have not received information we assume a total output of 150,000 gross of bottles and phials, as compared with 703,000 gross imported. As regards bangles the value of the imports in 1929-30 was Rs. 85 lakhs, so that even if the Firozabad estimate of Rs. 115 lakhs as the value of the present output of the Indian factories is approximately correct, there is still a considerable market open to capture by the Indian manufacturer. The position as regards lampware and miscellaneous manufactures is more obscure, but the information which we have received suggests that the present output is about 100,000 gross a year which at an average price of Rs. 16 a gross represents about Rs. 16 lakhs; and so long as Rs. 20 lakhs worth of lampware is imported it is evident that the Indian manufacturer still has plenty of scope for expanding his industry. The best estimate we can make of the value of the glassware now manufactured in India is as shown below:—

	Rs. lakhs.
Bangles	115·00
Bottles and phials	6·50
Lampware	16·00
Sheet	2·50
	140·00

Estimate of total market.

62. We are now in a position to form an estimate of the Indian market as a whole by taking the value of the goods imported together with that of the Indian manufactures. We have seen that the imports of 1930-31 reflect the universal trade depression and we therefore use the figures of 1929-30 as representing more normal conditions and thus affording a more correct view of the relation between the value

of the glass manufactured in India and that of imported glassware:—

TABLE XXV.

	Value of imports 1929-30.	Value of goods manufactured in India.
	Rs. lakhs.	Rs. lakhs.
Bangles	85·23	115·00
Beads and false pearls	30·61	...
Bottles and phials	39·49	6·50
Lampware	21·08	16·00
Scientific glassware	1·34	...
Sheet and plate	30·97	2·50
Tableware	13·29	...
Other glassware	29·92	...
TOTAL .	251·93	140·00

If our calculations of the products of Indian factories are reasonably correct, the Indian industry, which in 1919 supplied one-fourth of the Indian market is now supplying about half the market for bangles, beads and false pearls and rather less than one-sixth of the market for other kinds of glassware. Taking bangles, beads and false pearls together, being articles of a similar nature, we find that the Indian market still affords ample scope for extension of the Indian industry even if we accept the figure of Rs. 115 lakhs as the value of the articles now manufactured in the country. We have been informed that India is practically the only market in the world for glass bangles; and there is no reason why, with improved and more economical methods of manufacture, the Indian factories should not produce all the qualities and varieties of bangles required to meet the demands of all the markets in the country. Of the Rs. 39·49 lakhs worth of bottles imported approximately Rs. 15·5 lakhs worth were sodawater bottles, with which the Indian manufacturer has hardly begun to compete; the value of other bottles and phials imported was about Rs. 24 lakhs, and when we consider that the Indian industry now produces only Rs. 6·50 lakhs worth of bottles which represent less than a third of the capacity of the works now equipped for the manufacture of bottles, it is evident that the market is ample to absorb not only the whole of the output of the present glass factories working to full capacity, but to afford scope for the establishment of new works. As regards lampware the figures in the table are not strictly comparable; for the figure of Rs. 16 lakhs under Indian manufacture includes besides lampware various other kinds of blown and pressed ware, and is really comparable with a figure which includes besides the Rs. 21·08 lakhs shown against lampware, part of the Rs. 13·29 lakhs shown against Tableware and part also of the Rs. 29·92 lakhs shown against "Other glassware"; there

is no reason why the Indian industry should not capture a considerable part of this business. The capacity of the two factories now equipped for the production of sheet glass is about Rs. 10·92 lakhs worth a year; from information received from Collectors of Customs we find that in the last three years the value of the sheet glass imported was roughly double that of the plate glass. So, if Rs. 20 lakhs of the Rs. 30·97 represent sheet glass, it will be seen that there is a considerable market open to the Indian industry beyond the capacity of the factories now making that kind of glass. It is perfectly clear that apart altogether from plate glass, scientific glassware, the best tableware and electric bulbs, which the Indian industry has not yet attempted to make, there is in India a market sufficient not only to absorb the whole of the products of the factories now in existence, but also to encourage the establishment of new factories. Nor are the opportunities of the industry confined to the Indian market; there has always been an export of glass from India; in 1888-89 the value of this export trade (chiefly bangles) was Rs. 0·42 lakhs. In the years before and during the war, it varied from Rs. 3 to Rs. 7·5 lakhs, about Rs. 1·5 lakhs representing Indian manufactures and the balance re-export of imported wares. Immediately after the war there was a sudden increase in exports which reached Rs. 19·5 lakhs in 1919-20, since when they have fallen steadily to Rs. 5 lakhs in 1929-30 and Rs. 3 lakhs in 1930-31. Most of this trade is with countries to which Indians emigrate, *e.g.*, Ceylon, the Straits Settlements, Iraq, Aden and Arabia, East and South Africa, the Fiji Islands; and there is no doubt that it represents largely glass bangles which are required just as much abroad as at home. We have also been informed of exports by land to Persia, Afghanistan and Tibet though we have not seen any figures indicating the extent of this trade. Another consideration which favours the development of the glass industry in India is that at present much less glass is used in India than in other countries, and that a much more rapid increase in the demand for glassware may reasonably be expected. But even without anticipating the future in this way a consideration of the present imports into the country indicates that there is already a market waiting to absorb as much glass as the industry in India can produce.

Summary.

63. Our examination of the various factors which constitute the natural advantages postulated by the Fiscal Commission in an industry which advances a claim for protection has satisfied us that the glass industry substantially complies with this condition. Of the raw materials, sand is the bulkiest and this is present in abundance, and there is good reason to think that by suitable treatment much of the Indian sand might be rendered fit for the manufacture of the best glass. Soda ash is not at present obtainable in the country but this disadvantage is balanced by the other natural advantages possessed by the industry. The manufacture of soda ash has been achieved successfully in India; and there is good reason for expecting an early resumption of its manufacture when supplies will at

once become available in the country. Lime is available in unlimited quantity. Of other raw materials such small quantities are required that in their case the question of advantage hardly arises; but some of them, *e.g.*, saltpetre, borax and manganese dioxide are readily obtainable. The presence of suitable refractory materials and the quality of the coal available in the country constitute definite advantages. The disadvantages ascribed to Indian labour at early surveys of the industry have now largely disappeared and certainly do not outweigh the advantages of its abundance and its adaptability. And finally the existence of a great market throughout the country, which may be expected to expand even more rapidly than in other countries, and the opportunities for export both by sea and land constitute a further advantage. We are therefore satisfied that on the balance the glass industry does possess such natural advantages as to justify its claim for protection.

CHAPTER III.

The Case for Protection and Proposals for Assistance.

Kinds of glassware considered.

64. Under our terms of reference we are required to examine all representations received by the Government of India from manufacturers of glass claiming protection for the glass industry along with any others of a similar nature which may be brought to our notice in the course of the enquiry. The original representation from the All-India Glass Manufacturers' Association to the Government of India was dated 4th July, 1926, and in it they claimed that protection should be granted to the manufacture of all classes of blown and pressed glassware and of bangles. Subsequently in 1929 the United Provinces Glass Works applied for protection also for the sheet glass industry. In addition to these, the Allahabad Glass Works, Naini, in their representation have asked for protection for figured and ribbed glass. The principal classes of articles may for the purpose of our enquiry be classified as follows:—

(1) Sheet glass, plain and figured.

(2) Blown ware, *e.g.*, bottles and phials, globes, chimneys, jars, etc., and pressed ware, *e.g.*, glass tiles, inkstands, bowls, dishes, etc.

(3) Bangles, beads and false pearls.

In discussing the applicability of the second and third conditions laid down by the Fiscal Commission and in determining the measure of protection required, if any, we propose to deal with each class of glassware separately.

(1) *Sheet glass, plain and figured.*

Plain sheet glass at present produced only in one factory.

65. Plain sheet glass is manufactured at present only by one factory—the United Provinces Glass Works at Bahjoi. We estimate that taking sheet glass at an average thickness of 1/16″ the maximum annual capacity of the factory is 116,240 boxes of 100 sq. ft. each. At current prices this represents a total value of over Rs. 7 lakhs. The Trade Returns do not show the quantity or value of imported sheet and plate glass separately. But on the information supplied to us by Collectors of Customs in reply to our enquiries, we understand that judged by value the imports of sheet generally exceed those of plate. The total imports of sheet and plate in 1930-31 was Rs. 23·87 lakhs and we are inclined to think that about Rs. 15 lakhs out of this represent the value of sheet imported. The annual capacity of the sheet glass factory at Bahjoi is thus nearly half

the market for sheet glass in India. A large proportion of the existing market for sheet glass is necessarily to be found in Bombay and Calcutta. A factory having a capacity equivalent to nearly half the Indian market should be in a position to command a substantial portion of the market existing in the ports. It is therefore necessary to consider whether a factory situated at an upcountry centre such as Bahjoi is suitably located with reference to the market. In this respect a factory situated in Calcutta has an apparent advantage. Moreover, Calcutta is much nearer the principal coalfields in India and since coal is a very important item of expenditure in the manufacture of glass, this constitutes an additional advantage for a factory located in Calcutta. Further, so long as the Indian glass industry is dependent on imported soda ash, a factory in Calcutta will save the cost of transporting its soda inland. Before, therefore, we can assume that the location of a factory at Bahjoi is not uneconomical as compared with one at Calcutta it is necessary to consider the relative costs.

Situation of United Provinces Glass Works not uneconomical.

66. The sand required by the Bahjoi factory is obtained partly from Bargarh which is at a distance of 363 miles from Bahjoi and partly from Swami Madhopur at a distance of 241 miles; sand is obtained in Calcutta mainly from Bargarh, the distance being over 500 miles. The present rates for sand delivered at works are approximately 10 annas 6 pies per maund at Calcutta and 7 annas 3 pies at Bahjoi and the quantity required per ton of sheet glass is 1,623 lb. On these figures the cost of sand per ton of glass may be estimated at Rs. 4 less at Bahjoi than at Calcutta. The railway freight on soda from Howrah to Bahjoi is 14 annas per cwt. The price of soda ash for delivery in the United Provinces is however less by 4 annas per cwt. f.o.r. Calcutta. The nett disadvantage is therefore 10 annas which on the quantity consumed (519 lb.) amounts to about Rs. 3 per ton of glass. Lime is obtained at Bahjoi in the form of limestone from a distance of 459 to 486 miles, while in the largest glass factory in Calcutta it is obtained from Katni about 650 miles from Calcutta and is bought in the form of burnt lime and employed as a mixture of burnt and slaked lime. The price of limestone at Bahjoi is 9 annas 6 pies per maund while the price of burnt lime at Calcutta is Rs. 2 per maund. Before the burnt lime is used it is slaked. Assuming a loss on ignition of 15 per cent. 300 lb. of slaked lime (equivalent to 255 lb. of burnt lime) may be substituted for 471 lb. of limestone. Accordingly the cost of lime per ton of glass may be estimated at Rs. 3 less at Bahjoi than at Calcutta. But we have no information regarding the cost of burning the limestone to lime, and since this accounts in part for the difference in prices, we propose to neglect any advantage which Bahjoi may have in the case of this material. The freight on salt cake from Calcutta to Bahjoi is Rs. 1-1-10 per cwt. and on a consumption of 122 lb. represents a disadvantage of Rs. 1-3-5. Other raw materials are used in negligible quantities in the manufacture of sheet glass and may be disregarded in discussing this question. As

regards coal, the rates are Rs. 8 per ton delivered at Calcutta and Rs. 13 per ton at Bahjoi. The present consumption may be taken approximately at 3 tons of coal per ton of sheet glass. But some allowance must be made for wastage in transit and the presence of slack which the factories are at present unable to utilise. Accordingly it may be estimated that the cost of coal per ton of glass is Rs. 28 at Calcutta and Rs. 45 at Bahjoi. Rates of wages are considerably lower at Bahjoi as may be expected. If we take the rate of wages paid for unskilled labour as our standard the Calcutta rate is more than double that in force at Bahjoi. The present cost of labour per ton of glass at Bahjoi is approximately Rs. 19 and on the ratio suggested, the cost at Calcutta may be fixed at not less than Rs. 38. As regards freight advantage on finished goods it is difficult to arrive at any reliable estimate. But an approximate idea may be obtained by assuming that on full output the sales will be divided in equal proportion between port and upcountry and that a place like Allahabad situated midway between Bahjoi and Calcutta represents a typical upcountry market. On this basis the freight advantage for the Bahjoi factory per maund of sheet glass including packing in upcountry markets is Rs. 1-3-0 and the freight disadvantage in Calcutta is Rs. 0-14-0 representing on the whole output a nett advantage of Rs. 0-2-6 per maund or Rs. 4-4-0 per ton of sheet glass. The position may be summarised as follows:—

TABLE XXVI.

Advantage for Bahjoi as compared with Calcutta . plus per ton of glass
Disadvantage ditto ditto . minus ,, ,,

	Rs	A.	P
Sand	+4	0	0
Soda	−3	0	0
Saltcake	−1	4	0
Coal	−17	0	0
Labour	+19	0	0
Freight on glass	+4	4	0
TOTAL .	+6	0	0

With a gradual increase in the output of glass at Bahjoi, the increased demand for labour may result in some increase in the rate of wages. On the other hand, there is considerable room for economy in the use of coal as compared with the present consumption of 3 tons per ton of glass and every reduction in coal consumption will reduce the disadvantage of Bahjoi under that head. It is necessary to explain that the figures arrived at should not be regarded as possessing exact validity but rather as illustrating the relative position of port and upcountry centres of production. They appear to us to justify the conclusion that the situation of Bahjoi as a centre for the sheet glass industry is not uneconomical as compared with Calcutta.

67. We proceed now to examine the cost of manufacturing sheet glass at the Bahjoi factory. The works expenditure per 100 cases of 100 sq. ft. each during the three years of its working as submitted by the Company is as follows:—

Works expenditure at Bahjoi in the last three years.

TABLE XXVII.

	1929	1930	1931
	Rs.	Rs.	Rs
Raw materials—			
(a) Sand	46·9	46·6	46·6
(b) Soda ash and saltcake	220·1	215·3	212·7
(c) Limestone	17·4	17·3	16·7
(d) Refractories (including repairs)	22·0	18·9	13·3
Works labour	119·4	110·0	104·0
Power and fuel	360·9	298·3	251·4
Supervision and office establishment	44·2	41·1	31·5
Packing	117·2	110·7	90·0
Selling expenses	23·2	30·9	30·5
Miscellaneous (including depreciation	88·0	77·0	54·0
TOTAL	1,059·3	966·1	850·7

The percentage of breakage in the factory is at present 19 per cent. as against 34 per cent. in 1929. Practically the whole of the broken glass is re-melted and used for manufacture. No credit, however, is taken for the value of the broken glass in the cost statements. This is in accordance with the general practice of glass factories both in India and elsewhere under which no account is taken of the cost of broken glass either on the debit or the credit side, the expenditure under this head being set off against the credit realised.

68. The total output in cases of 100 square feet was 34,980 in 1929, 35,200 in 1930 and 29,817 in 1931. In judging the effect of variations in output on the works expenditure, it is necessary to take into account the number of days for which the factory was in operation in each year. The total number of working days in 1929 was 308, in 1930, 271 and in 1931, 159, giving a daily output of 113·5 cases in 1929, 130 cases in 1930 and 187·5 in 1931 against a maximum daily capacity of 350 cases per day. The increase in the daily output since 1929 explains to a large extent the reduction in the expenditure on power and fuel, since both the furnace and the machines were worked to greater capacity during the period of working. A larger daily output also accounts for the reduction in the expenditure on works labour, the bulk of unskilled labour being employed at daily rates. The

Differences in works expenditure during the last three years explained.

reduction under supervision and office establishment in 1931 is entirely due to the retrenchment in the salaries of the staff and the reduction in 1930 as compared with 1929 was due to the larger output in 1930. The miscellaneous items which consist of stationery charges, rent, taxes and depreciation show a very considerable reduction in 1931 as compared with 1929. The reduction is mainly under depreciation which is calculated only for the actual periods for which the factory worked, the period of working in 1931 being little more than half of that in 1929. The reduction in the expenditure on materials reflects to a large extent changes in prices. That under refractory materials is due to the fact that the Company are now able to make a considerable proportion of the refractories they require in the works. The only refractories now imported are a few clay blocks used in the tank furnace where wear and tear are most severe. These blocks made of Grossalmerode clay are imported from Germany. Furnace and drawing blocks (debiteuses) are now made locally out of Indian fireclay from Jubbulpore whilst silica bricks are obtained from Kumardhubi. The reduction under packing is due to the increasing use of packing materials available locally in close proximity to the works. The only item which shows an increase in 1931 as compared with 1929 is selling expenses and this is to be traced to the keener competition with imported sheet glass.

Estimate of future works cost.

69. We shall now attempt to estimate the extent to which these costs may be reduced in future. It is very doubtful whether any reductions can be made in the cost of materials. Reduction in the expenditure on materials is possible in two ways—by economy in the consumption of materials and by reduction in their prices. The latter depends on several uncertain factors, especially in the case of soda ash, which for the time being is imported, and since soda ash is the most expensive item among the main raw materials it is impossible to make any estimate of future costs. As regards the quantities of materials consumed, the level of consumption already attained is such that it is hardly likely that any further economy may be achieved. According to the present practice of the works, assuming that only pure dry materials are used, the total weight of the materials used per ton of melted glass is 2,735 lb. made up as follows:—

	Lb.
Sand	1,623
Soda ash	519
Limestone	471
Saltcake	122
	2,735

This gives a loss in melting of 18·0 per cent. of the total weight of materials and is the minimum which can be expected, for if the materials contain moisture, the quantities of materials used per ton of glass will require to be increased in proportion to the moisture content. In addition loss of material by volatilisation in the fur-

nace, say 3 to 5 per cent., must be taken into account. It is obvious that neither the cost of raw materials nor that of packing can be reduced by reason of increase in output except to the extent that purchases in bulk may secure more favourable quotations from dealers. This, however, in the circumstances, is a negligible factor. The most important item under which reduction in cost may be reasonably expected is power and fuel. The consumption of coal per ton of sheet glass in 1931 was 3·1 tons. It is admitted by the Company that this figure is too high and that with improved practice and larger production it can be brought down to 2 tons. According to our information the consumption of coal in Belgian sheet glass works employing the same machinery as at Bahjoi does not exceed 1·33 tons. This is coal of considerably superior calorific efficiency to Indian coal, and making allowance for this and other factors we think that a consumption of 2 tons may be regarded as being within the reach of an Indian factory. On this basis the cost of coal per 100 cases should come down to $\frac{2}{3 \cdot 1}$ of the cost in 1931 or Rs. 162. Some allowance, however, should be made for the 15 per cent. increase in the freight on coal since January 15th. Including this, the future cost of coal per 100 cases may be taken as Rs. 175. As regards other items of expenditure, it is reasonable to assume that if output is increased some reduction will be possible under each of them. Works labour includes a considerable complement of skilled and trained labour which must be kept in employment even in times of reduced output, the cost of which when production is increased is spread over a larger output. For the same reason, a greater reduction should occur under supervision and office establishment. An increase of output might necessitate the employment of a few additional hands for supervision and clerical work, but the extra cost of this establishment would certainly be less than the cost of the additional labour required and consequently there should be a greater reduction of cost per unit of output under this head than under the head of labour. We think that if production is increased to the maximum capacity of the works or more than three times the annual output of 1931 the following reductions on the 1931 costs should be possible:—

	Rs
Works labour at 20 per cent	20·8
Supervision and office establishment at 30 per cent .	9·4

The only other item under which cost may be reduced is 'Miscellaneous' which includes rent, taxes, stationery and postage, and depreciation. According to the usual practice of the Board we propose to consider depreciation separately under overhead charges. The audited figures for 1931 have not yet been published, but we find from the profit and loss statement for 1930 that miscellaneous expenses including postage and stationery but excluding depreciation amounted to approximately Rs. 8,000 which on the output of 1931 amounts to Rs. 27 per 100 cases. We assume the same expenditure for 1931. An increase of output will involve no increase of rent or taxes, though there will be some increase in the cost of

postage and stationery. On the whole we consider it probable that on increased production there will be a saving of expenditure per unit under this head of 40 per cent. or Rs. 10·8. The total works expenditure on full output per 100 cases may be estimated as follows:—

TABLE XXVIII.

		Rs.
Works Expenditure, 1931		850·7
Deduct—		
	Rs.	
Power and fuel	76·4	
Works labour	20·8	
Supervision and office establishment .	9·4	
Miscellaneous, rent, taxes and postage .	10·8	
		117·4
Future expenditure		733·3

The Company have included depreciation in their statement of works expenditure under the head 'Miscellaneous'. The total charges under miscellaneous in 1931 amount to Rs. 54 per 100 cases. We have taken Rs. 27 as the miscellaneous expenditure in 1931 if depreciation is omitted. Hence the future works expenditure excluding depreciation becomes Rs. 733·3 less Rs. 27 or Rs. 706·3 per 100 cases. We regard a figure of Rs. 7 per case of 100 sq. ft. as a reasonable estimate of the works cost which may be attained on full output.

Estimate of overhead charges and profit.

70. In estimating the overhead charges of the factory, we propose to take the present block account of the Company as a fair capitalisation. The capacity of the Company's works represents a reasonably economical unit for a sheet glass factory. A sheet glass works employing four Fourcault machines fed by a regenerative tank furnace and having a combined capacity of 350 cases of 100 square feet per day may be regarded as a factory of normal equipment and capacity. The block value of the Company's sheet glass plant including land, buildings, plant and machinery stood at Rs. 6·95 lakhs on December 31, 1930. The plant and machinery were bought and erected as recently as 1928. We do not believe that a factory of the same equipment and capacity could now be installed at a lower cost. The Income Tax rates of depreciation are stated to be $2\frac{1}{2}$ per cent. on buildings and 10 per cent. on machinery and furnace. We think that a higher rate of depreciation should be allowed on the furnace, which we propose to fix at 20 per cent. Calculating at these rates we get a total

depreciation of Rs. 66,060* which on a full capacity of 116,240 cases a year works out at Rs. 0·57 per case of 100 sq. ft. The amount of working capital required may be taken as the equivalent of half the year's works expenditure on which interest at 7½ per cent. will amount to Rs. 0·26 per 100 sq. ft. The works have a managing agent but all charges on this account are included under supervision and office establishment in the works expenditure. Profit at 10 per cent. on the capital divided by the maximum output will work out at Rs. 0·60 per 100 sq. ft. The fair selling price on full output will then stand as follows:—

	Per 100 sq. ft.
	Rs.
Works cost	7·00
Depreciation	0·57
Interest on working capital	0·26
Profit	0·60
	8·43

Allegation that present price of imported sheet glass is uneconomical.

71. It is now necessary to examine how far on these figures the industry will be able eventually to dispense with protection. The current price at Calcutta of sheet glass corresponding approximately in weight and size to the glass manufactured at Bahjoi is Rs. 6-4 c.i.f. per 100 sq. ft. At this price it is obvious that even on full production and with a revenue duty as high as 25 per cent. and the present advantage on exchange, Indian sheet glass will be unable to compete with imported glass. It would appear, therefore, that no case for protection could be established in the light of the third condition laid down by the Fiscal Commission. It is however contended by the Company that the price charged for sheet glass imported into India from Belgium, which is the principal country of supply, does not cover all manufacturing charges and that the goods should therefore be regarded as being dumped. Belgian sheet glass imported into India is described by the trade as being of fourth quality, representing the cheapest variety of sheet glass exported. This, it is argued, is generally sold at a price which covers only material and labour and other direct charges. We have been at some pains to examine

	Rs.
*Machinery—Rs. 5,32,485 at 10 per cent.	53,248
Furnace—Rs. 50,000 at 20 per cent.	10,000
Buildings—Rs. 1,12,480 at 2½ per cent.	2,812
	66,060

this statement since in our opinion the third condition of the Fiscal Commission cannot be held to cover cases where the inability of the Indian industry to meet foreign competition without protection is due to the fact that such competition is unfair competition.

Cost of manufacturing sheet glass in Belgium in 1926

72. The following figures relating to the manufacturing costs of Belgian factories employing the Fourcault process have been given for the year 1926*. The figures are in German currency (Rpf) per sq. metre.

TABLE XXIX.

Raw materials	16·7
Fuel	20·1
Other materials	20·9
Wages and salaries	25·0
Amortisation and other expenses	17·5
Overhead charges	3·8
	104·0

The first four items which cover materials of all kinds, wages and salaries, and fuel amount to Rpf. 82·7 per sq. metre which at gold parity of exchange is equivalent to 7·85 shillings per 100 sq. ft. The total cost as given above, namely, Rpf. 104 per sq. metre is equivalent at par of exchange to 9·87 shillings per 100 sq. ft. This covers all charges including depreciation and transport to Antwerp. It does not however cover interest on capital or profit and it is doubtful if it includes selling expenses. The figures are for sheet glass of average thickness corresponding approximately to Indian sheet glass. The wholesale market price in Calcutta in 1927 was Rs. 7-12-0 per 100 sq. ft. Excluding dealer's commission this gives a landed duty paid price of Rs. 7-8-0 or taking duty at 15 per cent., a c.i.f. price of Rs. 6·52 equivalent to 9·78 shillings; this is lower than the works cost *plus* depreciation as given above. The freight on sheet glass from Antwerp to Indian ports in September last was 25 shillings per 1015 kilos on the usual Conference terms. Allowing for primage and deferred rebate and assuming the weight of packing to be about 1/7th the gross weight, we arrive at a figure of 1·23 shillings per 100 sq. ft. of 16 oz. glass. Assuming that freight rates have not changed since 1927, we get a price of 8·55 shillings f.o.b. Antwerp This is 0·70 shillings above the cost of materials, fuel and labour but 1·32 shillings less than works cost *plus* depreciation excluding interest and profit.

* "Die Deutsche Glasindustrie" Verlegt bei G. S. Mitter und Sohn, Berlin, 1921, Table 44, p. 63.

73. We have been placed in possession of more recent information regarding Belgian costs which we have good reason to regard as fairly representing the present level of costs in a Belgian factory employing the Fourcault process. The figures are given in sterling (shillings) at par of exchange per 100 sq. ft.

Recent cost of manufacture in Belgium.

TABLE XXX.

	Shillings.
Raw materials	1·50
Refractories	0·06
Labour	1·90
Fuel and Power	1·39
Management and Office	0·16
Packing	1·53
Repairs and depreciation	1·17
	7·71

The wholesale market price in Calcutta early in 1931 was Rs. 6-4-0 per case of 100 sq. ft. Excluding dealer's commission, this corresponds to a duty paid price of 9 shillings. Taking duty at 15 per cent., this gives a c.i.f. price of 7·82 shillings. If we assume freight at 1·23 shillings, we get a price f.o.b. Antwerp of 6·59 shillings. It will be seen that as in 1927 the f.o.b. price is slightly higher than the cost of materials, fuel and labour including packing but considerably less than the total works expenditure *plus* depreciation excluding interest and profit.

74. Although we claim no finality for the figures on which this examination of Belgian costs is based, we are convinced that the figures justify the conclusion that the sheet glass imported into India is sold at a price with which it would be unfair to compare Indian costs for the purpose of determining the claim to protection. We propose therefore to base our examination of the case for protection on a comparison of the Indian costs with those of Belgium as far as these can be approximately determined. If we take the Belgian costs of 1926 as the basis of comparison, we get a c.i.f. price at Indian ports for Belgian sheet of 9·87 *plus* 1·23 shillings = 11·10 shillings equivalent to Rs. 7·40 per 100 sq. ft. The future costs we have estimated for the Indian factory excluding interest on working capital and profit is Rs. 7·57. This includes selling expenses at Rs. 0·30 for which it is doubtful if provision is made in the Belgian costs for 1926. On these figures the Indian costs approximate so closely to the Belgian that it is clear that the industry would be able eventually to dispense with protection. The position of the Indian industry appears less favourable if we take the Belgian costs for 1931 for the purpose of comparison. On these costs the c.i.f. price of Belgian sheet is 7·71 *plus* 1·23 = 8·94 shillings or Rs. 5·96 against a corresponding Indian price of Rs. 7·57. The Indian price is, therefore, higher by Rs. 1·61 a case so that the

Allegation of uneconomical prices justified.

Indian manufacturer will not be able to compete without a 27 per cent. duty. It does not therefore appear at first sight that the Indian industry will eventually be able to dispense with protection. But the gap is not really so wide as it appears. In the first place, the Belgian price does not include any allowance for landing or selling charges. This allowance at Re. 0·05 per case for landing charges and Re. 0·30 for selling charges would bring the Belgian price up to Rs. 6·31 a case. Secondly, the sheet glass manufactured at Bahjoi is slightly heavier than the average size for which the Belgian costs have been calculated. The Belgian glass weighs 16 oz. a sq. ft. while the average weight of the Indian glass is about 17½ oz. but the price obtained by the Indian manufacturer is determined by the price of imported glass weighing 16 oz. The greater weight of the Indian sheet glass represents additional materials costing about 4 annas per 100 sq. ft. This disability should disappear as skill in production at Bahjoi increases. Thus for the purpose of strict comparison, the Indian costs should be reduced by Re. 0·25 to Rs. 7·32 a case. There is still another factor for which allowance should be made in the Indian cost before a comparison is made with Belgian. The import duty at 25 per cent. on soda ash and other materials adds about Re. 0·50 a case to the Indian cost. The import duty on soda ash in Belgium generally amounts at par of exchange to less than 4 pies per cwt.* whereas the Indian duty is nearly Rs. 1-8-0 per cwt. This is obviously an unfair handicap on the Indian industry. If the Indian and Belgian costs are adjusted with reference to these factors, the resulting position will be as follows:

TABLE XXXI.

		Rs.
Indian Fair Selling Price		7·57
Deduct—		
	Rs.	
Additional cost of material	0·25	
Duty on soda ash, etc.	0·50	
		0·75
Nett		6·82

		Rs.
Belgian c.i.f. price		5·96
Add—		
	Rs.	
Landing charges	0·05	
Selling expenses	0·30	
		0·35
Nett		6·31

* The Belgian tariff contains a maximum duty equivalent to 15 pies per cwt. and a minimum equivalent to less than 4 pies, the latter being generally the effective rate.

On these figures the Indian industry will be able to hold its own with a revenue duty of 8 per cent.

Conditions of the Fiscal Commission satisfied.

75. The results of the foregoing examination may be summarised as follows. At the current prices at which sheet glass is imported from Belgium, it is doubtful if the Indian industry will be able eventually to dispense with protection. But as we have seen, these prices do not include certain charges for which we have made allowance in the future fair selling price estimated for the Indian industry. The two prices, therefore, are not strictly comparable, and no proper judgment regarding the claim to protection can be based on them. If provision is made in the import price for all charges included in the Indian fair selling price, it appears probable that the landed duty free price will enable the Indian sheet glass industry to compete ultimately with little or no protection. The sheet glass industry in Europe depends on a large export market for the bulk of its sales, and this enables the manufacturer to charge different prices in different markets according to local conditions. In glass as in other commodities, India is pre-eminently a cheap market in which it is often worth while for the European manufacturer to sell such of his goods as are not of standard quality at prices which cover little more than his direct charges. For the realisation of overhead charges and the return on capital, he depends largely on sales of good quality ware in other markets where there is a steady demand for it. On the other hand, the Indian sheet glass industry at the present stage is confined to the home market for its sales and is obliged to sell all its output at the low prices at which imported sheet glass is sold. In judging the permanent prospects of the Indian industry, it would be hardly reasonable to base our conclusions on prices determined by sporadic competition of this character. It is for this reason that we have preferred to examine the claim to protection on a comparison of Indian costs with those of Belgium. Judged by this standard, there appears to be a reasonable probability of the Indian industry being able ultimately to face foreign competition without the aid of protection. We therefore hold that the conditions laid down by the Fiscal Commission are substantially satisfied in this case.

Progress of the Indian sheet glass industry satisfactory.

76. The progress made by the factory during the three years of its working may be judged from the following figures:—

TABLE XXXII.

—	Days worked.	No. of machines.	Boxes produced.	Boxes per day.	Boxes per day per machine.
1929	300	3	34,080	113·6	37·9
1930	271	3	35,200	129·9	43·3
1931	159	4	29,830	187·6	46·9

The percentage of efficiency based on the output per machine as compared with its maximum capacity is as follows:—

1929	43·0
1930	49·3
1931	53·3

It is interesting to compare these figures with those attained by the German sheet glass industry* employing the same process in the first three years since the commencement of manufacture—

1st year	28·8
2nd year	59·2
3rd year	76·5

Considering the unfair competition to which the Indian industry has been exposed and the difficulties experienced in training skilled labour in India, we think that the beginning made by the sheet glass industry in India should on the whole be regarded as satisfactory.

Average fair selling price during the period of protection

77. In calculating the measure of protection required by the industry, we consider that a reasonable estimate of the average annual output which may be attainable during the period of protection is 75,000 boxes of 100 sq. ft. This amounts to about two-thirds of the maximum capacity of the plant and represents an average daily output of 225 boxes. We think that if protection is granted, a daily production on this scale should be attained throughout the year excluding holidays. Towards the end of the period there is no reason, assuming protection to be effective, why the factory should not be in a position to produce upwards of 90 per cent. of the maximum capacity. There is enough market in the country for the whole output and the labour will by then have acquired sufficient skill and experience to approach full efficiency. If, at the beginning, the annual output approximates to that of 1931, an average output representing two thirds of the total capacity during the period of protection is obviously a fair estimate on which to base the scheme of protection. It may be assumed that the works expenditure during the period will be approximately the average of the cost attained in 1931 and of the estimated cost on full output. The works cost in 1931 was Rs. 8·23 per 100 sq. ft. excluding depreciation and the cost estimated on full output is Rs. 7. Accordingly we assume an average works cost of Rs. 7·62 during the period of protection. On this expenditure interest at 7½ per cent. on working capital estimated at 6 months expenditure is Rs. 0·29. We think that depreciation and profit should be calculated at rates corresponding to full output. This would leave the Company a smaller profit than 10 per cent. at the beginning unless special efforts were made to accelerate production. A higher rate of depreciation and profit would not offer the same inducement for extending output and reducing costs.

* Die Deutsche Glasindustrie, table 28, p. 40.

The fair selling price which we estimate for the period of protection is as follows:—

TABLE XXXIII.

	Per 100 sq. ft.
	Rs.
Works costs	7·62
Depreciation	0·57
Interest on working capital	0·29
Profit	0·60
	9·08

Measure of protection.

78. The current price of imported Belgian sheet glass corresponding to Indian glass is Rs. 6-4-0 c.i.f. Calcutta. This price reflects the temporary rise in prices which has been brought about by the recent depreciation in rupee exchange and does not afford a suitable basis for determining the protection required in the long run by the Indian industry. We propose therefore to base our estimate on the prices which prevailed earlier in 1931. The wholesale market price then was Rs. 6-4-0 which less 15 per cent. revenue duty and dealer's commission represents a c.i.f. price of Rs. 5·22. The difference between this price and the fair selling price estimated by us is Rs. 3·86. We have estimated in paragraph 66 that as compared with Calcutta, the Bahjoi factory has a freight advantage on finished glassware of Rs. 4-4-0 per ton of glass which amounts to Rs. 0·23 per 100 sq. ft. We do not think that any deduction should be made from the measure of assistance on this account. In the first place, the figure represents only an approximate estimate and is based on assumptions which cannot be regarded as entirely accurate. Moreover, the freight from Bahjoi to Calcutta on which this estimate is based is Rs. 0-12-0 per maund. Bombay is however a larger distributing centre for sheet glass than Calcutta and the freight from Bahjoi to Bombay is 15 annas per maund. Any advantage obtained on sales in Calcutta will therefore be neutralised by sales in Bombay. Making some allowance for the prejudice in the market against Indian glassware generally, we propose that the measure of assistance should be fixed at Rs. 4 per 100 sq. ft. On the c.i.f. price we have assumed namely Rs. 5·22 protection at this rate is equivalent to a duty of 75 per cent. It may be pointed out however that a considerable proportion of this is really in the nature of an anti-dumping duty. If due allowance were made for interest on working capital and profit and for other legitimate charges in the import price, a duty at the rate proposed would not exceed 50 to 55 per cent. of the c.i.f. price.

Figured and ribbed glass.

79. The Allahabad Glass Works, Naini, have applied for protection for the manufacture of figured and ribbed glass for which they have installed the necessary plant and machinery. The total capacity of the figured glass plant at the Allahabad Works

is estimated to be 15,000 to 20,000 sq. ft. per day. There has been no production of figured and ribbed glass at the works since 1927. The total output so far has been about 2,00,000 sq. ft. manufactured in 1927, representing a fortnight's capacity. It is clear that no reliable estimate of the cost of manufacturing this class of glassware can be formed on the results of a fortnight's production four years ago. Figured glass is classified for Customs purposes under "Sheet and Plate", and any duty proposed for plain sheet glass will apply therefore to figured and ribbed glass. If the Allahabad Glass Works are encouraged by the duty which we have proposed to undertake production on a more economical scale and for a continuous period, it will be open to them to apply for a reconsideration of the duty if the rate now suggested is found to be inadequate.

Plate glass.

80. Plate glass is not at present manufactured in India. There is therefore no case for protecting it, nor is there any information regarding the probable cost of manufacturing it in India on which if there were a case, our proposals could be based. We understand that it would be difficult for Customs purposes to distinguish first class thick sheet, or polished sheet, from plate glass. For this reason we propose that protection for sheet glass should be granted in the form of a specific duty of Rs. 4 per 100 sq. ft. and that the same duty should apply to plate as well as sheet. This duty in many cases will be considerably lower than the revenue duty on plate and in hardly any case will be higher. In order to prevent the loss of revenue which may result in cases where the revenue duty is higher than the specific duty, we recommend that the tariff relating to sheet and plate should be fixed at Rs. 4 per 100 sq. ft. or the revenue duty, whichever is higher.

Objections to bounties

81. Since there is only one factory producing sheet glass in India at present, we have considered the advisability of granting protection for sheet glass in the form of a bounty. We think however that the grant of a bounty is open to several objections. In the first place, it is important in the case of the glass industry, for reasons we have explained elsewhere, that protection should be guaranteed for a sufficiently long period to enable the industry to undertake the necessary improvements. If protection takes the form of a bounty, legislative and administrative considerations will render it impossible to grant protection for so long a period as we have in view. Secondly, it is equally important that protection should be granted in a form which will induce the manufacturer to improve the quality of his product, a consideration which is of special urgency in the case of Indian glassware. If protection takes the form of a bounty, it will be almost impossible to provide, by inspection or otherwise, for the necessary improvement in quality. On the other hand, if protection takes the form of an import duty and the manufacturer is obliged to sell in competition with the better classes of imported glassware, it will provide a stimulus for improvement in quality since no protection can be realised except by sales in the

ordinary course of business. An import duty gives the manufacturer no more than a good start in the race. But a bounty, even where it is granted on production of invoices, by assuring a safe minimum return reduces the incentive to progress. Thirdly, it should be mentioned that although there is only one sheet glass factory at present, the Indian market is large enough for the erection of at least another factory. It is probable that this may happen almost immediately and in that case an indeterminate additional burden will be placed on the public revenues.

(2) *Blownware and Pressed ware.*

Examination based on the costs of the Calcutta Glass and Silicate Works.

82. Blown glassware consisting chiefly of phials, bottles, globes, and chimneys is the commonest class of glassware manufactured by Indian factories. Pressed glassware is also made in small but increasing quantities. The principal manufacturers who have given evidence before us in support of the claim for protecting the blownware industry are the Bengal Glass Works, the Calcutta Glass and Silicate Works, the Upper India Glass Works, Ambala, the Allahabad Glass Works and the Ogale Glass Works. The last mentioned works have also applied for the protection of pressed ware. In all these works the varieties of articles produced are so numerous that it has been a matter of no little difficulty to determine the cost of manufacture per unit of each class of glassware. Some of the factories, being under individual proprietorship and therefore free from any obligation to publish audited statements of expenditure and receipts, maintain accounts in a form which makes the investigation of their costs for our purpose exceedingly difficult, if not impossible. An additional difficulty in the case of certain factories is that their location from the point of view of supply of raw materials and power or accessibility to the market is so unfavourable as to render their costs totally unrepresentative. In other cases the output is too small and the process of manufacture followed is uneconomical. In view of these difficulties we propose to base our examination of the blownware industry on the costs of the Calcutta Glass and Silicate Works, which we regard in many respects as the most suitable for our purpose. Their average output during the past five years has been considerably above 1,000 tons a year, varying from 1,150 tons in 1930 to 1,725 tons in 1926. The glass is melted in the works in a regenerative tank furnace instead of in crucibles. And in 1930, the last year for which they have supplied us with statements of expenditure, the output has been almost entirely confined to one class of glassware, namely medicine phials varying in capacity from 1 oz. to 8 oz. The works belong to a public limited liability company and publish audited statements of accounts. The location of the works is in Calcutta which, while not so advantageous in some respects as certain parts of Upper India, possesses very considerable advantages in other respects and is generally more favourable than the location of factories in Western India.

Works expenditure in 1930.

83. The Company have furnished us with statements of their expenditure at the works during the past five years. The last year for which figures have been supplied is 1930. These are shown below:—

TABLE XXXIV.

	Total expenditure in 1930. Rs.	A.	P.
Raw materials—			
(a) Sand	8,850	0	0
(b) Soda ash	23,390	0	0
(c) Lime	3,616	0	0
(d) Other materials including cullet	17,597	4	0
	53,443	4	0
Work labour	71,401	14	0
Power and fuel	36,650	2	6
Supervision and office establishment	22,417	3	0
Repairs	2,813	11	3
Packing	4,291	8	9
Selling expenses	7,427	9	9
Miscellaneous (stationery, rent, taxes, etc., and interest on working capital)	26,034	12	7
TOTAL	2,24,480	1	10

The total output of melted glass during the year was 1,150 tons. Since the loss by breakage in the works is approximately 20 per cent., the corresponding output of finished glass may be taken as 920 tons. On this output the average expenditure per ton of finished glass is as follows:—

TABLE XXXV.

	Per ton of finished glass. Rs.
Raw materials—	
(a) Sand	9·62
(b) Soda ash	25·41
(c) Lime	3·93
(d) Other materials including cullet	19·13
TOTAL	58·09
Works labour	77·61
Power and fuel	39·84
Supervision and office establishment	24·37
Repairs	3·06
Packing	4·66
Selling expenses	8·07
Miscellaneous including interest	28·30
TOTAL	244·00

From an examination of the Company's works expenditure during the past five years, we find that the average works cost per unit of glass has remained more or less stationary during the period in spite of a substantial reduction in output. This is very largely the result of drastic economies effected by the management in view of the severe competition from imported glassware.

Reduction in works expenditure during the last 5 years.

84. The output in terms of melted glass during the period has been as follows:—

TABLE XXXVI.

	Tons.
1926	1,725
1927	1,650
1928	1,300
1929	1,325
1930	1,150

In spite of a decline in the total output of 33 per cent. there has been a substantial saving in several items of expenditure. The reductions per ton of glass in 1930 as compared with 1926 are shown below:—

TABLE XXXVII.

	Gain + Loss – Per cent.
Materials	+ 4
Works labour	– 9
Power and fuel	*Nil*
Supervision and office establishment	*Nil*
Repairs	*Nil*
Packing	+ 40
Selling expenses	+ 60
Miscellaneous	– 30

It will be seen that the Company have substantially reduced their expenditure on packing and selling mainly as the result of adopting more economical methods of packing and distribution. They have avoided incurring any increase in expenditure on supervision, repairs and power and fuel. The reduction under materials is negligible and is to be explained mainly by changes in prices. The cost of works labour although higher than in 1926 was slightly lower than in 1927. The principal increase, as is to be expected, occurs under 'Miscellaneous' which includes standing charges that necessarily do not admit of reduction.

85. The works possess three tank furnaces in working condition. There is also a fourth furnace which has however been left unfinished and cannot be operated at present. The combined capacity of the three furnaces is stated by the Company to be 12 tons of melted glass per day which assuming 330 working days in the

Equipment and normal capacity of the works.

year gives a maximum capacity of approximately 4,000 tons. At present the whole process of manufacture is performed by means of manual labour. The Company purchased a few years ago and still possess a bottle making machine of the O'Neill type and engaged the services of a few skilled workmen from America to operate it. But on account of difficulties in connection with the retention of these men in the employment of the Company and also the lack of working finance, the machine was never brought into operation. So long as the manufacture of glass is based entirely on manual labour, it is reasonable to take the capacity of the works as being equivalent to the capacity for production of the tank furnaces provided a sufficient supply of skilled labour is forthcoming and the labour can be accommodated in the works, regard being had to the lay out of the furnaces. The output in 1930 was less than a third of the total melting capacity. Taking into consideration the difficulty of increasing the skilled labour to the extent necessary for the full capacity of the tanks, we consider that normally the total capacity of the works should be fixed at 2,500 tons a year. In estimating the future costs which may be attained by the works, we propose to take 2,500 tons as the maximum output which may reasonably be expected on the present equipment and lay out.

Cost of materials.

86. The works cost per ton of finished glass in 1930 has been set out in detail in paragraph 83. The expenditure on materials in this statement is based on the proportions actually employed by the works in the composition of their batch. We have been unable to obtain from the representatives of the Company who gave evidence before us the precise proportions of the various materials used by them. Nor are we satisfied that the proportions ordinarily employed in glass works in India manufacturing blownware are the most suitable, having regard to economy in working and to the quality of glass produced. We propose, therefore, to base our estimate on the following proportions which we consider generally reasonable for blownware—

TABLE XXXVIII.

		Per ton of melted glass.
		Cwt.
Sand		16
Soda		5½
Lime (burnt)		2½
Other materials—		
	lb.	
Saltpetre	46	½
Manganese dioxide	6	
Arsenious oxide	4	

This statement represents the quantities of the various materials that would be required per ton of glass if no cullet obtained in the

works were used. As a matter of fact the total percentage of breakage in the factory at present amounts to nearly 20 per cent.* We consider that with more experience and better organisation this should be reduced to 10 per cent., which would still be in excess of the normal percentage in European factories. This broken glass finds its way back into the furnace and therefore allowance shoud be made in estimating costs for the saving in materials which this represents. If no cullet were used, the cost of materials per ton of glass would be as follows† :—

TABLE XXXIX.

	Rs.
Sand	14·29
Soda ash	40·98
Lime	6·13
Other materials—	
Saltpetre	2·26
Manganese dioxide	0·83
Arsenious oxide	0·75
TOTAL	65·24

If it is assumed that the breakage will be 10 per cent. the cost per ton of melted glass should be raised by 10 per cent. in order to get the cost per ton of finished glass. This increase may be set off against the corresponding reduction in cost on account of the use of broken glass. On this basis Rs. 65·24 may be taken as the cost of materials per ton of finished glass.‡

87. With regard to the other items in works expenditure it is necessary to consider how far an increase in output to 2,500 tons will reduce costs. In the case of sheet glass we assumed a reduction of 20 per cent. under works labour on an increase corresponding to more than three times the existing output. We assume here in view of a smaller proportionate increase a reduction of 15 per cent., *i.e.*, from Rs. 77·61 to Rs. 65·97. Under power and fuel we consider as in the case of sheet glass that with reasonable economies in consumption and

Cost above material.

* This refers to breakage which may be recovered as cullet and excludes the small proportion of wastage which cannot be recovered.

† The costs shown in this Table are not comparable with the costs of materials as given in paragraph 83. The latter does not include the expenditure on materials obtained in the form of cullet in the works. A considerable quantity of broken glass was also purchased by the works from outside. The materials thus obtained, if bought as such, would cost a great deal more. In respect of supplies of broken glass, Calcutta is favourably situated but is not typical of the position of the Indian glass industry as a whole.

‡ The question of cullet was not raised in this form in our discussion of sheet glass. This is because the costs in that case were based on the actual costs at Bahjoi in which allowance had been made for the use of cullet. Here we are proceeding not on actual costs but the costs based on a sample composition.

with fuller and more continuous production, tank furnace operation should not ultimately require more than 2 tons of coal per ton of finished ware. Allowing for wastage in transit and the presence of unusable material and the recent increase in the freight on coal, we may take a price of Rs. 9-4-0 per ton of coal which yields a fuel cost of Rs. 18·50. Under supervision and establishment we think a reduction of 20 per cent. should be possible, *i.e.*, from Rs. 24·36 in 1930 to Rs. 19·49. Under repairs, packing and selling expenses we do not think that the figures would admit of further reduction. But we think a reduction of 30 per cent. under miscellaneous should be easy to attain, *i.e.*, from Rs. 28·30 to Rs. 19·80. With these reductions the costs above material will be as follows:—

TABLE XL.

	Rs.
Works labour	65·97
Power and fuel	18·50
Supervision and office establishment	19·49
Repairs	3·06
Packing	4·66
Selling expenses	8·07
Miscellaneous	19·80
	139·55

The cost per ton of finished glass in 1930 was based on a breakage of 20 per cent. If breakage is reduced to 10 per cent. a corresponding reduction should be made in the cost above materials except packing which will bring it down to Rs. 124·56* The necessary adjustment in the cost of materials has been already made. Hence the total expenditure on full output will be—

	Per ton of finished glass. Rs.
Cost of materials	65·24
Cost above materials	124·56
	189·80

Fair selling price of hand-made glassware.

88. Throughout these calculations we are assuming that while the melting will be done in a regenerative tank furnace, the manufacture of finished ware will be carried on by hand. What adjustments should be made if manual labour were replaced by automatic machinery is a question which we reserve for later consideration. Meanwhile we shall attempt to determine what the future fair selling price would be if manufacture were based entirely on manual labour. The block account of the Company at the 31st of December 1930 was Rs. 1,73,104-10-3. The total amount of depreciation set aside was Rs. 2,14,498-10-0. The original block

* This figure is arrived at by taking 8/9ths of Rs. 139·55 less packing and then adding the cost of packing to the resultant figure.

was thus Rs. 3,87,603-4-3. The plant and buildings were mainly erected during the war and a very considerable reduction therefore should be made in the block value in arriving at the present replacement cost. The Company suggest a reduction of 50 per cent. which we consider reasonable. The replacement cost is therefore Rs. 1,93,801-10-1. This however includes the cost of the O'Neill machine which has never been worked and also the cost of the unfinished furnace. Deducting the value of these two items, the nett replacement value may be estimated in round figures at Rs. 1,50,000 distributed as follows:—

	Rs.
Buildings	30,000
Furnaces, kilns, etc.	1,00,000
Tools, implements and other accessories	20,000
	1,50,000

The total productive capacity of the furnaces at present is 4,000 tons of melted glass. Since we have assumed a smaller maximum capacity, some reduction should be made in the capital cost of furnaces, say, to Rs. 75,000 representing the cost of two furnaces with a combined capacity of 9 tons a day, which will reduce the total replacement value to Rs. 1,25,000. The land on which the buildings are erected is leased land and its value is therefore omitted. The total depreciation on the block may be estimated as follows:—

	Rs
Buildings Rs. 30,000 @ 2½ per cent.	750
Furnaces Rs. 75,000 @ 20 per cent.	15,000
Tools, implements and other accessories Rs. 20,000 @ 10 per cent	2,000
	17,750

We have assumed a total output of 2,500 tons of melted glass or taking breakage at 10 per cent. 2,250 tons of finished ware. Depreciation per ton of finished ware is therefore Rs. 7·89. Interest on working capital has already been included in the works expenditure under the head 'Miscellaneous'. The managing agents receive no commission but are allowed Rs. 750 a month for office establishment charges which are included in the works expenditure and no further allowance therefore need be made under this head. Profit at 10 per cent. amounts to Rs. 12,500 or per ton of finished ware Rs. 5·55. The fair selling price is thus:—

	Per ton of finished glass. Rs.
Works cost	189·80
Depreciation	7·89
Profit	5·55
	203·24

Fair selling price of machine-made glassware.

89. We shall now proceed to estimate what the fair selling price would be if hand labour were replaced by automatic machinery. We have assumed an output of 2,250 tons of finished glassware if hand labour is employed. There would be a considerable increase in output if hand labour were replaced by machinery because it does not appear to be possible to accommodate sufficient hand workers around the furnaces to work out their full capacity. Employing machines, a total production of 2,800 tons of finished glassware would be a reasonable estimate. Two O'Neill bottle making machines working three shifts a day would be sufficient for this output. The total labour cost per year on this equipment and output may be roughly estimated as follows:—

TABLE XLI.

	Rs.
3 skilled operators at Rs. 750 a month	27,000
6 Helpers at Rs. 50 a month	3,600
6 Attendants for compressors, etc., at Rs. 50 a month	3,600
8 Men on furnaces at Rs. 50 a month	4,800
Extra labour	3,000
	42,000

Taking the total output at 2,800 tons of finished ware, the labour cost works out at Rs. 15 per ton, which is about one-fourth of the labour cost on hand manufacture.* Although a smaller proportion of labour cost on machine production as compared with hand production of bottles is in fact attained in other countries, we consider the proportion we have taken to be a reasonably safe figure under Indian conditions. As regards the cost of power and fuel, we think that the same cost as in hand labour should be taken. The increase in output will mean a considerable reduction in the fuel cost per unit of output which however should be set off against the increased cost of power on machine production. There will also be some reduction as the result of increased production under 'Supervision' and more particularly under 'Miscellaneous'. This again should be set off against the higher cost of repairs in machine production. The total works expenditure on machine production per ton of finished ware will then be—

	Rs.
On hand production	189·80
Less reduction in labour†	43·64
	146·16

	Rs.
* Works labour per ton of finished ware (hand labour)—	
At 20 per cent. breakage	65·97
At 10 per cent. breakage (at 8/9ths)	58·64

† Rs. 58·64 *less* Rs. 15·00 = Rs. 43·64.

We consider that at current prices an O'Neill machine with feeder, conveyor, compressor and motor delivered and erected will cost approximately Rs. 40,000 at Calcutta. The capital expenditure on two machines will be Rs. 80,000. In addition, provision must be made for tools, feeder replacements and for moulds. Feeder parts wear rapidly and moulds tend to become obsolete. Under this heading we suggest a figure of Rs. 30,000 with a depreciation of 20 per cent. We therefore fix the addition to the capital expenditure on account of machines at Rs. 1,10,000 and including Rs. 15,000 for additional building at Rs. 1,25,000. The total amount of depreciation on these figures will be—

TABLE XLII.

	Rs.
Buildings—Rs. 30,000 *plus* Rs. 15,000 at 2½ per cent.	1,125
Furnaces—Rs. 75,000 @ 20 per cent.	15,000
Machinery—Rs. 80,000 @ 10 per cent. and Rs. 30,000 @ 20 per cent.	14,000
	30,125

	Hand Labour. Rs.	Machine. Rs.
Total block	1,25,000	2,30,000
Depreciation	17,750	30,125

Taking output on machine production at 2,800 tons of finished ware, depreciation per ton is Rs. 10·76.* Profit at 10 per cent. on the whole block is Rs. 23,000 which per ton of finished glass amounts to Rs. 8·21. The fair selling price therefore is—

	Per ton of finished glass. Rs.
Works cost	146·16
Depreciation	10·76
Profit	8·21
TOTAL	165·13

Conditions of the Fiscal Commission satisfied if manufacture is based on machinery.

90. It is now necessary to examine how far in accordance with the figures we have estimated the Indian industry will be able to dispense with protection. The future fair selling price per ton on full output if hand labour is employed is Rs. 203·24. The Calcutta Glass and Silicate Works have confined their production in recent years mainly to dispensing phials of smaller sizes ranging from 1 oz. to 8 oz. in capacity. In the year 1930, on the costs of which our examination is based,

*Depreciation on sheet glass per 100 sq. ft. estimated by us on full output is Rs. ·57. Taking about 18 cases to a ton this works out to Rs. 10·26 per ton of glass.

the production consisted almost entirely of these small size phials. The average weight of the phials manufactured in 1930 was 1 ton per 40 gross. The future fair selling price based on hand labour is therefore Rs. 5·08 per gross of phials. If machinery is employed we have estimated a fair price of Rs. 165·13 a ton which per gross of phials amounts to Rs. 4·13. The Company have supplied us with the wholesale market prices of Japanese phials current in Calcutta in October 1931. They were as follows:—

TABLE XLIII.

	Per gross. Rs.	A.	P.
1 oz. dispensing phials	3	0	0
2 ,, ,,	3	12	0
3 ,, ,,	4	6	0
4 ,, ,,	5	0	0
6 ,, ,,	6	0	0
8 ,, ,,	7	8	0

The 4 oz. phial may be taken as typical of the whole class. The price of this size was Rs. 5 per gross, which almost exactly corresponds to the arithmetical average of the prices of the various sizes as given in the statement. Taking dealers' commission at 4 annas per gross and the duty at 20 per cent. we get a price without duty of Rs. 3·96. It will be seen that at this price machine made phials will eventually be able to compete without protection. As we point out later, the price realised by the Indian manufacturer is often considerably less than the import price. To the extent that this difference is due to inferior quality, the employment of up-to-date mechanical methods of production will go a long way towards removing it. Hand made phials, even at a cost corresponding to full output, will still require a duty of nearly 30 per cent. Actually the protection required will be higher than this because with hand production the difference in quality and finish between Indian and imported glassware will be more difficult to remove. It appears, therefore, that the ability of the industry to dispense with protection will depend on the extent to which hand labour is replaced by automatic machinery. Unless costs are reduced on a much larger scale than we are able to foresee, the future of the hand industry in face of foreign competition must remain precarious.

Measure of protection.

91. In estimating the measure of protection required, we must necessarily assume that during the period of protection the industry would make every effort to extend production by machinery. The scheme of protection should, therefore, be so framed that the full benefit of protection will not be realised unless machinery is employed, and that uneconomical methods of production are discontinued. We propose therefore to base our recommendations on the assumption that at the end of the period of protection manufacture will be carried on entirely by means of automatic machines for which we have made full allowance in our estimated costs, and that full

output will be attained. At the beginning of the period we shall assume a works cost corresponding to the actual cost incurred in 1930 and calculate depreciation and profit on the full output which may be attained on hand labour so as to encourage a rapid extension of production. On this basis the initial fair selling price will be:—

	Per ton of finished glass.
	Rs.
Works cost	244·00
Depreciation	7·89
Profit	5·55
TOTAL	257·44

At the end of the period the fair selling price would correspond to that estimated on full output based on machine production, namely, Rs. 165·13. The average of these two prices—Rs. 211·29—may be taken as the basis of the scheme of protection. At 40 gross of phials to a ton, this corresponds to Rs. 5·28 a gross. We have seen that the price of Japanese phials of this class without duty is Rs. 3·96. Since the principal competitor in this line of glassware is Japan, we shall be justified in basing our proposals on the price of Japanese ware. We have, however, received a great deal of evidence during this enquiry that the prices realised by Indian manufacturers are considerably below the prices of corresponding classes of imported glassware. This is partly to be accounted for by the general prejudice against Indian goods based on their assumed inferiority. But it is partly due also to the almost universal practice among Indian dealers, apart from any consideration of quality, of offering lower prices for Indian made articles on the ground that they do not bear sea freight and other incidental charges borne by imported articles. We find from an examination of the prices realised by Indian manufacturers of phials that they are generally lower than import prices by about a rupee per gross. With the introduction of more efficient and up-to-date methods of production and with better organisation among manufacturers, such as has been undertaken, for example, by the Ogale Glass Works, we have no doubt that a great deal of the existing prejudice against Indian glassware is bound to disappear, although some of it may still persist. If we assume that the present difference of a rupee per gross will be reduced eventually to a quarter of it, a figure of about 10 annas per gross will represent the average difference between Indian and import prices during the period of protection. It is necessary that allowance should be made for this difference in fixing the measure of protection. Otherwise the assistance granted to the industry will fall short of what it requires. Where the price realised by the Indian industry is lower than the import price, it is the former on which protection should be based, unless the difference is due entirely to inferior quality and inefficient methods of production. In the case of the glass industry it is clear from the evidence that a considerable

part of the difference is due to circumstances for which the industry is not responsible, such as the influence of importing interests and the general prejudice against Indian made goods. Although at present there is a difference of nearly a rupee between the import price of phials and the price realised by the Indian manufacturer, we propose to take into account only 10 annas in determining the measure of protection. The balance represents the extent to which on the average we think that the prejudice resulting from inefficient methods and inferior quality should disappear during the period of protection.* Deducting this we get an average realised price of Rs. 3·34 per gross against a c.i.f. price of Rs. 3·96. On this basis the measure of protection required for phials is:—

	Rs.
Average fair selling price	5·28
Average realised price	3·34
Difference	1·94

This corresponds to 49·0 per cent. of the c.i.f. price. We consider that the measure of assistance required should be fixed at 50 per cent. of the import price. Since the process of manufacture of larger bottles is identical with that of phials, it is unnecessary to examine their costs separately. We propose that the same rate of protection should apply to bottles of all classes as well as phials.

Cost of manufacturing globes and chimneys higher than bottles.

92. The other principal class of blownware which is manufactured in India is lampware. We have however been unable to ascertain with any approach to accuracy the cost of manufacture in Indian factories. The production of globes and chimneys is carried on in conjunction with several other classes of blownware and in some cases with pressed ware. The accounts maintained in the factories are such that it is impossible to distinguish the expenditure on each class of glassware made. We have, however, received sufficient evidence in the course of the enquiry to justify the general conclusion that globes and chimneys should be afforded the same assistance as bottles and phials. It is more expensive to manufacture globes and chimneys than bottles. The most important difference consists in the much higher percentage of breakage in the factory in the case of globes and chimneys. The quantity of glass which is wasted in cracking off the ends in the mould constitutes a heavy item of expenditure in the manufacture of chimneys as compared with bottles and phials. Although in future the difference in wastage may be considerably less than at present, it varies now from 35 to 50 per cent. Moreover, chimneys are more liable to be broken in the process of handling by workmen in the factory, especially where the works are not well organised and the workmen are inexperienced. There is again a higher proportion of breakage in the case of chimneys

* The allowance for prejudice is much larger than in the case of sheet glass. This is because the sheet glass factory is better equipped while the quality of imported sheet is generally the lowest.

in railway transit, and where efforts are made to reduce this there is a corresponding increase in the cost of packing. Additional labour cost is also incurred in cutting and grinding chimneys which is not necessary in the case of bottles. On the other hand, neck making is a process special to bottles and adds to the labour cost. But this is generally more than counterbalanced by the additional cost involved in cutting and grinding chimneys. There is also a further factor which makes chimneys more expensive to manufacture. Bottles may now be made almost entirely by automatic machinery which, as we have seen, reduces the cost of production very considerably. But globes and chimneys are still made by hand and even in America where the use of automatic and semi-automatic machinery is most extensive about half the production is still based entirely on manual labour. A large difference in the cost of producing the two kinds of articles per weight of glass is therefore to be expected. It is true that the freight on chimneys is somewhat higher since weight for weight they represent greater bulk and the packing is heavier and therefore to this extent import prices tend to be higher. On the other hand, Indian factories situated inland have for the same reason to bear heavier railway freight to the ports where the largest markets are to be found.

Measure of protection for bottles applicable to other kinds of blown-ware and pressed ware.

93. It is impossible on the data in our possession to attempt an estimate of the relative costs of manufacturing chimneys and bottles. But it appears to us probable that the difference in the costs is roughly proportionate to the difference in the market prices of the two classes of articles where they represent the same weight of glass. The price of globes and chimneys is generally higher, corresponding to the higher cost of manufacture. We therefore recommend that the measure of assistance which we have proposed for phials and bottles should be applied to globes and chimneys and to every other kind of blown glassware, calculated in each case *ad valorem*. On the same line of reasoning we propose that the assistance should be extended also to pressed glassware of all kinds. There is, we think, good reason for suggesting that the manufacture of blownware and of pressed ware, although they represent numerous varieties of articles, should be regarded essentially as a single branch of the glass industry in India. The question of coal consumption which is vital to the industry depends on the provision of up to date furnaces of economical capacity and on the possibility of keeping the furnaces fully and continuously at work. It is therefore essential that the output of the factory should be sufficiently large to admit of the full use of such furnaces. Since the cost of glassware depends to a large extent on the cost of melting, any falling off in the output of one class of goods is bound to react on the cost of every other class manufactured in the works. The relatively limited demand for glassware in India and the long distances which divide the principal markets render specialised production difficult. As far as hand made articles are concerned, whether made by blowing or pressing, there is little advantage in factories attempting to

specialise in particular lines of production. On the other hand, if different lines of production are concentrated in the same factory, the resulting economy in the cost of melting will bring down the general level of costs. In the present circumstances it would be an advantage for Indian factories to arrange their production in such a manner that small orders for different kinds of glassware could be supplied without the main line of production being interrupted. It follows, therefore, that if protection is considered desirable for any particular kind of blown or pressed ware, it is necessary to extend it to the whole industry as otherwise protection will prove ineffective.

94. The assistance we have proposed should be given in the form of an *ad valorem* duty. Specific duties are generally a more effective form of protection than *ad valorem* duties. But since the articles comprised in this group represent many varieties having different values, a uniform specific duty will be clearly inapplicable. We recommend, therefore, that on all kinds of blown and pressed glassware an *ad valorem* duty of 50 per cent. should be levied.

Specific duties unsuitable.

95. We have received a large number of representations from importers of excise and aerated water bottles objecting to the grant of protection to the manufacture of bottles. They complain that bottles made in India are unsatisfactory in respect of durability, appearance and uniformity of capacity and therefore are unsuitable for use in the liquor and aerated water trades. In some of the representations received by us it was stated by importers that excise departments in India objected to the use of Indian made bottles on the ground that the capacity of the bottles was not sufficiently uniform. We, therefore, addressed the Excise Commissioners in the various provinces on the subject and the following are extracts from some of the replies received:—

Representations from users of bottles.

Bombay.—"So far as the Bombay Excise Department is concerned there is no restriction on the use of bottles of Japanese or Indian manufacture on the ground of their capacity. For excise purposes it is immaterial whether Indian or imported bottles are used."

Central Provinces.—"Uniformity of capacity is generally irrelevant for the bulk of bottling is in respect of country spirit which is sold bottled only in quantities of 3 drams or 6 drams (10 and 20 ounces respectively) so that the bottles are never filled, and nominally 11 or 22 ounce bottles, even if not uniform, would leave a sufficient margin. In practice, the bottling contractors obtain their bottles locally or from Bombay and these are generally used whisky or beer bottles, mostly of European manufacture, but Indian made bottles are also extensively used."

Bengal.—"So far as Bengal is concerned, the representations from importers of glass bottles that bottles of Japanese

> or Indian manufacture are usually condemned by the Excise Commissioner is incorrect and no bottles, whether Japanese or Indian or of other countries have been condemned by this Department in Bengal."

These replies apparently represent the practice obtaining in most of the provinces in India.

Representation from the Government of the Punjab.

96. We have however received a letter from the Government of the Punjab which suggests that the practice in that province is different. With effect from April 1st, 1931, a system has been introduced in the Punjab by which all Indian made foreign spirit and country spirit distilled in the Punjab and sold for consumption in the province are to be bottled only in bottles bearing the words "Punjab Excise", figures showing the contents of the bottle, the name or mark of the manufacturer of the bottle, and a line on the neck up to which the bottle has to be filled in order to contain the proper quantity. It is stated that "these bottles are machine made in Europe, and although the contents of each bottle cannot be guaranteed by the manufacturers to be absolutely accurate in each case, the process of manufacture is so efficient that on the average these bottles contain almost exactly the quantity of spirit which they purport to contain". The Government further observe that "in India there is no factory capable of producing bottles with sufficient accuracy to meet the requirements of the Punjab Excise Department". It would appear that the innovation in the Punjab was adopted from the practice in force in the United Provinces with the addition of the requirement that a line should be moulded on the neck of the bottle. The Punjab Government have proposed, in view of these circumstances that bottles required for excise purposes should be exempted from any protective tariff which may be imposed until such time as accurate standardised bottles manufactured in India are on the market. Although the practice in the United Provinces is apparently the same as in the Punjab, we have received no communication from the United Provinces Government on the subject except an endorsement by the Excise Commissioner of the Province on a representation from Messrs. Carew & Co., distillers, to the effect that any increase in the price of liquor to the consumers is likely to lead to illicit distillation and loss of Government revenue.*

Objections to protection for bottles not valid.

97. The representations referred to in the preceding paragraphs raise two questions regarding the grant of protection to the manufacture of bottles. The first is whether the contention that there is no Indian factory capable of producing bottles required for excise purposes is correct, and the second whether the duty proposed

* Since writing the above, we have been informed that the Government of the United Provinces "are not in favour of the exclusion of liquor bottles from any recommendation affecting protection of bottle-making (glass) industry in India, which the Indian Tariff Board may have under consideration".

by us will increase the price of liquor to such an extent as to lead to illicit distillation. With regard to the first question, it may be pointed out that the possibility of manufacturing bottles with sufficient accuracy in respect of capacity depends partly on the use of automatic machinery and partly on the provision of experienced and skilled supervision in the works. There are in India at present factories such as the Allahabad Glass Works, Naini, which possess bottle making machines of reasonable capacity and efficiency. If sufficient assistance is granted to the industry to make increased production possible and for engaging adequate staff for supervision, we think it reasonable to assume that bottles suitable for excise purposes can be manufactured in India. We have carefully considered the proposal made by the Punjab Government to exempt this class of bottles from the protective duty. We are, however, unable to accept it on the ground that such exemption will deprive the Indian industry of any incentive to manufacture high class bottles and will definitely confine it to the production of inferior classes of bottles. We think that if the glass industry as a whole is considered deserving of protection, it is unfair to the industry and inconsistent with the objects of protection to confine it to the manufacture of inferior goods. So far as the difficulty in making superior glassware is due to the lack of adequate equipment and staff, protection will help to remove it. The position would be different if it were true, as some importers have suggested, that the raw materials available in India are unsuitable for the production of superior kinds of glassware. We have discussed the question of raw materials in detail in Chapter II and we do not consider that the defects of Indian materials are such as may not be removed by suitable treatment. As regards the effect of an increased duty on prices, it is only necessary to point out that at the current price of Rs. 13-2-0 per gross of pint bottles in India an increase in the duty from 25 to 50 per cent. will raise the price by little more than a quarter of an anna per bottle. The effect of this on the price of liquor will be negligible. The case for exempting aerated water bottles was argued before us by Mr. Meyer Nissim of Bombay who gave evidence on behalf of importers. The considerations which we have urged in the case of excise bottles apply equally to aerated water bottles. Mr. Nissim in explaining his point of view before the Board made it clear that if suitable materials could be found in India, he personally would not object to the grant of protection. We propose that the rate of duty which we have recommended should apply to all classes of bottles including soda water bottles.

Representations from other users of bottles.

98. We have also received representations from two Dairy Companies and from Messrs. C. & E. Morton (India), Limited, manufacturers of confectionery, objecting to the grant of protection to the manufacture of bottles. The former base their objection on the ground that natural advantages are lacking in India for the establishment of the glass industry. We have

examined the question of natural advantages in detail in another chapter and we are satisfied that the opposition to the claim for protection on this ground is not well founded. Messrs. Morton, Limited, complain that the manufacture of confectionery in India has been already burdened by the protective duty on sugar and that an increased duty on glass bottles will therefore seriously handicap the industry. In view of the fact that there is at present a duty of 50 per cent. on imported confectionery and that the import price of confectionery is relatively high, we do not think that the duty which we have proposed on bottles can be regarded by Indian manufacturers of confectionery as an unfair burden. It may also be pointed out that the Managing Agents of Messrs. Morton, Limited, are Messrs. Begg Sutherland and Company, who represent many of the largest manufacturers of sugar in India and were among the principal applicants for the grant of protection to the sugar industry.

(3) *Bangles, Beads and False Pearls.*

Statements of costs supplied by bangle manufacturers.

99. The manufacture of bangles is at present carried on principally at Firozabad in the United Provinces. Recently bangle factories have been started in other parts of the country of which one of the most important is the factory in Calcutta belonging to Mr. P. M. N. Mehta. We have been supplied with full particulars regarding the method of manufacture and cost of production of bangles at Firozabad by the Glass and Bangles Industrial Association who represent most of the local manufacturers. Mr. Mehta's factory has been in existence for little more than a year, and he has therefore been unable to send us a full statement of his actual costs for the period. He has however submitted a detailed estimate of his average weekly expenditure and output based on the year's working. There are considerable discrepancies between his estimate and the statement of costs supplied by manufacturers at Firozabad. These partly reflect variations in methods of production and in local prices of raw materials and coal, but are mainly due to differences in the quality and class of bangles made, the methods of packing and the proportions in which bangles of various colours are manufactured. By comparing the two statements and making the necessary adjustments, it is possible to make a fairly close approximation to the normal cost of manufacturing bangles in India.

Classes of bangles manufactured.

100. The bangles made by the Indian industry are of various classes, of which the most important are (1) Reshmi or Silky bangles, which are plain bangles made in different colours and possessing a bright, lustrous appearance, (2) Fancy bangles, which are also made in different colours and are decorated with widely varying artistic designs, (3) Rough bangles, which are heavy bangles of crude pattern lacking in finish and appearance and made by a primitive and uneconomical process. Of these the classes which

come into competition with imported bangles are reshmi and fancy bangles. The finer kinds of fancy bangles are generally imported from Czechoslovakia and command prices which vary enormously according to the kind of materials used, the decorative designs wrought on them and their size and weight. The bulk of the Indian production consists of reshmi bangles and in this the competition is principally with bangles imported from Japan. In estimating the costs of the Indian industry we propose to base our examination on the cost of producing reshmi bangles, partly because they represent the bulk of the Indian output and partly also for the reason that they form a more homogenous product of which it is possible to make a more accurate estimate of standard costs. On the other hand variations in the cost of manufacturing fancy bangles occur within such wide limits according to their design and quality that it would be completely misleading to estimate an average cost.

Future output of typical factory

101. The Glass and Bangles Industrial Association, Firozabad, have supplied us with a statement of costs incurred by a representative factory in 1930 on an output of 7,500 maunds or approximately 275 tons of finished reshmi bangles corresponding on a rough estimate to 350 tons of melted glass. In the case of sheet glass or blownware this output would generally be considered too small. The difference between bangles and those other kinds of glassware is that in the case of the latter the glass is melted most economically in a tank furnace which reduces coal consumption and increases the output. In the case of bangles however the necessity of making them in a wide assortment of colours makes a tank furnace unsuitable. The melting of different batches for the production of different colours makes it necessary to employ a pot furnace in which each batch can be melted in a separate crucible. The factory at Firozabad for which costs have been given has a seven pot furnace, each pot having a capacity of 7 maunds. Making a reasonable allowance for breakage of pots and for the delay in refilling a pot after emptying and taking the average life of a pot as six weeks, a furnace of this capacity should produce from 10,000 to 12,000 maunds of melted glass in a year or approximately 370 to 440 tons. The factory in question produced in 1930 bangles corresponding to 350 tons of melted glass. But of this, 75 tons were block glass purchased from other factories so that the output of glass melted from raw materials in the factory was only 275 tons during the year. Although in view of the employment of pot furnaces in bangle factories a smaller output may be taken as a reasonable basis for an examination of costs than we have assumed in the case of other kinds of glassware, yet we think that the actual output attained by the factory might have been somewhat larger. In estimating the cost which the industry may be reasonably expected to attain, we propose to take an output of 400 tons of melted glass per annum. The proportion of breakage in the factory is now approximately 25 per cent. in the case of reshmi bangles. With better organisation and more careful handling, this may be reduced to 15 per cent,

On this proportion of breakage 400 tons of melted glass would correspond to 340 tons of bangles.

Differences in costs of materials.

102. The largest item of expenditure in the manufacture of reshmi bangles is the cost of materials. The total cost of materials excluding crucibles, refractories and fuel as given in the Firozabad statement is Rs 31,000 for an output of 350 tons of melted glass, including the materials used in making the block glass purchased during the year. On the estimate of weekly expenditure submitted by Mr. Mehta, the corresponding cost of materials for the same output works out at over a lakh and half of rupees. Some part of the difference is due to the different rates at which sand, soda and lime were purchased. But the largest difference is in the proportion of colouring materials used especially selenium and cadmium sulphide. These are expensive materials and are used chiefly in the manufacture of red bangles. The quantities are determined not merely by the degree of brilliancy and depth of colour to which the bangles are made but also by the proportion of red bangles to the total output. The representatives of the Glass and Bangles Industrial Association admitted in their evidence that their bangles are inferior in appearance to imported bangles, while Mr. Mehta is endeavouring to manufacture bangles equal in quality and appearance to imported bangles for which he requires larger quantities of selenium and cadmium sulphide. We have also received some evidence that in certain markets such as Madras and the larger cities generally there is a greater demand for red bangles than in other markets. A manufacturer producing bangles for these markets would therefore have to use bigger quantities of selenium and cadmium sulphide. In view of these variations in practice, we propose to frame our estimate of the cost of materials on what we regard as a suitable composition for bangles of each colour and then to average the costs according to the proportions in which bangles of various colours are generally sold in the country.

Costs of compositions for different colours.

103. The three colours which may be regarded as typical are Red, Yellow or Amber and Green. For bangles of good quality, comparable with imported reshmi bangles, the following compositions stated in quantities per ton of glass may be considered suitable:—

TABLE XLIV.

Red (1).

	lb.	Rs.
Sand	1,764	14·08
Soda ash	582	38·71
Slaked lime	247	6·00
Selenium	26·5	205·38
Cadmium sulphide	17·5	48·12
Arsenious oxide	17·5	3·28
		315·57

Red (2).

	lb.	Rs.
Sand	1,600	13·24
Soda ash	664	44·17
Borax (cryst)	133	13·06
Zinc oxide	116	20·97
Slaked lime	83	2·00
Selenium	25	193·75
Cadmium sulphide	25	68·75
Arsenious oxide	25	4·69
		360·63

Amber.

	lb.	Rs.
Sand	1,764	14·08
Soda ash	582	38·71
Slaked lime	247	6·00
Sulphur	26·5	1·42
Arsenious oxide	17·5	3·28
		63·49

Green.

	lb.	Rs.
Sand	1,764	14·08
Soda ash	582	38·71
Slaked lime	247	6·00
Potassium chromate	9	9·00
Copper oxide	9	4·50
Arsenious oxide	17·5	3·28
		75·57

At current prices the costs work out as follows:—

	Per ton of glass. Rs.	
Red (1)	315·5	
Red (2)	360·5	
		Rs.
Average Red	...	338·0
Amber	...	63·5
Green	...	75·6

On the evidence we have received we find that the proportions in which these colours are generally sold in the country may be taken approximately as 50: 30: 20. On these figures the weighted average cost of materials per ton of melted glass works out at Rs. 203·20. We have assumed that in future the breakage in the works will not exceed 15 per cent. This then will represent the

proportion of cullet which will be available for use. The cost per ton of glass may therefore be reduced in this proportion which will bring it down to Rs. 172·70.

104. In order to get the complete cost of materials in a pot furnace it is necessary to add the cost of crucibles. At Firozabad the total expenditure in 1930 amounted to Rs. 600 to which must be added about Rs. 150 as the cost of crucibles on the block glass purchased. This gives a cost of Rs. 2·14 per ton of melted glass. On Mr. Mehta's estimates it amounts to Rs. 5·92 per ton of glass. The main differences are:—(1) Mr. Mehta uses imported crucibles which cost Rs. 45 each, while at Firozabad the crucibles are made locally and they cost generally Rs. 20 to Rs. 25 each, and (2) Mr. Mehta estimates the average life of a crucible as 1 month whereas at Firozabad they claim two months and in some cases more. We think the cost should be estimated on the assumption that crucibles are locally made and that they have an average life of one and a half months. On these assumptions we arrive at a cost of Rs. 3·24 per ton of melted glass.

Cost of crucibles.

105. The cost of works labour at Firozabad on the whole production in 1930 was Rs. 25,000, to which must be added about Rs. 500 as the cost of labour on the block glass purchased. This is equivalent to Rs. 72·85 per ton of melted glass. Mr. Mehta's estimate of expenditure on labour for 60,000 dozen pairs which represents his output for 6 days is Rs. 1,406-4-0. He calculates that the quantity of glass required for a dozen pairs is 4 oz. On this ratio, the cost of labour per ton of glass is Rs. 210. The rates of wages in Calcutta, as we have pointed out in the section on sheet glass, are at least double those prevailing in upcountry towns in the United Provinces. Apart from this, two Japanese operators are employed by Mr. Mehta at a monthly salary of Rs. 300 per mensem exclusive of board and lodging which on the present output amounts approximately to Rs. 35 per ton of glass. There are no imported labourers at Firozabad where all the skilled work is done by hereditary classes of bangle makers. The existence of these hereditary skilled workers is one of the principal advantages which Firozabad possesses as a bangle making centre. Considering the fact that the bulk of the Indian production is centred at Firozabad and that it possesses a large supply of relatively skilled labour, we propose to base our estimate on the Firozabad costs. Since the labour is remunerated almost entirely by piecework, it is doubtful if an increase in output will reduce the cost per unit of glass. On the other hand, we found during our visit to Firozabad that conditions of labour are far from satisfactory and we think that if protection is granted to the bangle industry, efforts should be made by the Glass and Bangles Industrial Association to improve them in respect of rates of wages and the provision made for suitable conditions of work in the factories and for the comfort and welfare of workmen. The attention of the

Cost of works labour.

Association whose representatives appeared to be alive to this fact should be directed immediately to this aspect of the industry. Taking this into consideration we propose to fix the future cost of labour at Rs. 100 per ton of glass.

Cost of power and fuel.

106. The total cost of power and fuel at Firozabad on an output of 350 tons of melted glass is given as Rs. 10,000. Taking the price of coal at Rs. 12 a ton delivered at works or Rs. 13-8 including wastage and other losses, the average consumption of coal in the whole process of manufacture calculated per ton of melted glass is 2·11 tons. As has been pointed out, 75 tons out of the 350 tons used in the factory were bought in the form of block glass. The fuel consumed in originally melting this glass should strictly speaking be regarded as part of the coal consumption during the year. Taking this at a minimum of 1 ton of coal per ton of melted glass, we get an average consumption over the whole output of 2·32 tons of coal. Mr. Mehta gives a consumption of $2\frac{1}{2}$ tons of coal per 5,400 lb. of melted glass and in addition an expenditure of Rs. 30 for gas and electricity on the same quantity of glass. Taking coal at Rs. 9-4 a ton, the expenditure on gas and electricity represents a coal consumption of 3·24 tons of coal giving a total of 5·74 tons for 5,400 lb. of glass or 2·38 tons of coal per ton of glass which corresponds closely to the average figure at Firozabad. The Firozabad figure however includes the coal expended on the block glass purchased. Excluding this, we get $2\frac{1}{4}$ tons of coal which may be regarded as probably the best figure attainable on a pot furnace. The relatively small consumption of coal at Firozabad which this figure indicates is partly due to the high proportion of soda ash used in the composition of the batch. Glass containing a high proportion of soda is more quickly melted and therefore consumes less coal. But the quality of the glass suffers thereby; it is mechanically weaker and less durable. In the compositions which we have adopted, we have allowed a smaller proportion of soda ash than is customary at Firozabad. The proportion usually adopted at Firozabad is nearly 50 per cent. of the weight of sand, whereas it will be noticed that we have proposed about one-third. Consequently, it is necessary to provide for a larger fuel consumption. We propose, therefore, to fix the consumption of coal at 3 tons per ton of glass. Making allowance for wastage, etc., in transit and for the recent increase in railway freight, we estimate the cost at Rs. 44 per ton of melted glass. It appears to be the general practice at Firozabad to sell the cinders from the furnace for which there is sufficient local demand. A deduction of Rs. 3 per ton of glass may be made on this account, leaving a nett cost of Rs. 41.

Cost of supervision and repairs.

107. Expenses of supervision and office establishment at Firozabad amount to Rs. 6·57 per ton of glass. Mr. Mehta's estimate is Rs. 33 which is far too high and cannot be accepted. With some increase in output the supervision charges at Firozabad should come down to Rs. 6. The cost of repairs and maintenance including refractory materials is Rs. 6·28 per ton of glass at Firozabad and

miscellaneous expenses Rs. 5·71. Of these miscellaneous expenses may be reduced to Rs. 4·5 with increase in output.

Cost of packing.

108. The cost shown in the Firozabad statement under 'Packing' is only Rs. 5·7 per ton of glass. The usual practice of manufacturers at Firozabad is to string bangles together and sell them unpacked in bunches. Imported bangles are invariably packed in wrapping paper and cardboard boxes bearing attractively designed labels and consequently fetch better prices in the market. In estimating the costs of the Indian industry as compared with the cost of imported bangles, it is necessary to make allowance for packing. Mr. Mehta estimates the cost of packing including cardboard boxes, wrapping paper and labels and incidental charges at 4½ pies per dozen pairs of bangles. This figure is, we think, too high. We found in the course of the Match enquiry that in a medium sized factory at Bombay the cost of packing, including wooden cases, wrapping paper, labels and all labour charges amounted to about 2 pies per dozen boxes of half size matches, only hand labour being employed. This does not include the cost of cardboard but on the other hand, includes more labels and corresponding labelling charges. We consider that an allowance of 2½ pies per box of dozen pairs of bangles would be ample. Assuming about 900 gross pairs of bangles to a ton of melted glass this would amount to Rs. 140·62 per ton of glass.

Selling expenses.

109. Selling expenses are not shown in the Firozabad statement. As the largest centre of bangle manufacture in India it is also the main centre of wholesale trade and manufacturers find little difficulty in disposing of their products. The necessity for a selling organisation in connection with the works does not, therefore, appear to arise. But the very low prices realised by Firozabad manufacturers point to the conclusion that what is saved on selling arrangements is probably lost in the low realisations. We think, in accordance with normal commercial practice, some allowance should be made on this account. A sum of Rs. 15* per ton of glass may be considered reasonable.

Overhead charges and profit.

110. We do not consider it necessary to make separate allowance for depreciation. It will be seen that we have allowed Rs. 6·28 per ton of glass for repairs and maintenance which on an output of 400 tons amounts to about Rs. 2,500 a year. This represents the cost of a furnace and in addition leaves a margin for occasional renewal of refractory materials. This is sufficient both for ordinary current repairs and for depreciation against substantial replacements. There are no separate managing agency charges at Firozabad; these are included under supervision and office establishment. The Glass and Bangles Industrial Association have estimated their

* We have allowed about Rs. 6 per ton for sheet glass and Rs. 8 to 9 for blownware. Since there is more handling in bangles, Rs. 15 is not excessive in proportion.

capital requirements including fixed and working capital for a reshmi bangle factory equipped with one furnace of the ordinary Japanese type as Rs. 21,000 which we accept as a reasonable figure. Allowing interest at 10 per cent., this works out at Rs. 5·25 per ton on an output of 400 tons.

Fair selling price.

111. The fair selling price of reshmi bangles calculated per ton of melted glass is as follows:—

TABLE XLV.

	Rs.
Materials	172·70
Crucibles	3·24
Works labour	100·00
Power and fuel	41·00
Supervision and office establishment	6·00
Repairs and maintenance	6·28
Miscellaneous	4·50
Packing	140·62
Selling expenses	15·00
Profit and interest	5·25
TOTAL	494·59

Fair selling price per dozen pairs.

112. Bangles are sold in the market in dozens of pairs, and it is therefore necessary to determine the number of reshmi bangles which are ordinarily represented by a ton of glass. According to the Glass and Bangles Industrial Association the weight of 40 toras or gross of pairs is one maund. If breakage in the works is taken at 15 per cent., 40 gross of pairs will represent 1·17 maunds of melted glass. On this ratio, a ton of melted glass is equivalent to 930 gross of pairs of bangles. Mr. Mehta estimates that it requires 4 oz. of glass to make one dozen pairs. This corresponds to a proportion of 747 gross to a ton of glass. It is obviously difficult to reach a definite conclusion on the point since the sizes and therefore the weights of bangles show a wide range of variation. At our request, the Department of Industries, Bombay, arranged for the weighing of reshmi bangles of representative sizes in the market and has found the weight of 1½ lakhs of pairs of bangles to be about a ton. Allowing for breakage at 15 per cent., this gives a proportion of 885 gross to a ton of melted glass. We propose to take for our purpose 900 gross to a ton which is roughly intermediate between the Firozabad estimate and that of the Department of Industries. On this proportion, the fair selling price which we have estimated per ton of glass works out at 8·79 pies per dozen pairs.

Price of imported bangles.

113. From recent quotations which we have received, we find that the price of reshmi bangles as commonly assorted for shipment to India in November last was 2·6 to 2·7 sen per dozen pairs f.o.b. Japanese port: reshmi bangles of this class packed for shipment measure 7·5 cubic feet per

504 dozen pairs. According to our information, freight from Japan is 10 yen per ton of 40 cubic feet less 10 per cent. deferred rebate. Incidental charges including insurance, etc., amount to 1·8 yen per ton and landing charges to about 3 per cent. of the c.i.f. price. Taking the yen-rupee exchange at gold parity we arrive at a landed, duty free price of 8·12 pies per dozen pairs. It will be seen therefore that working on full output and assuming reasonable economies, the Indian industry would not require assistance except to the extent of 8 per cent. of the import price.

Conditions of the Fiscal Commission satisfied

114. Although in estimating future costs we have allowed for such economies as may reasonably be attained under present conditions of working, we think that there are further economies possible for which we have made no provision in this estimate. The manufacture of bangles is a branch of the glass industry in which there is considerable scope for the employment of simple semi-automatic machinery, and the use of such appliances by increasing the rate of output will lead to a reduction in the unit cost of labour. We have provided in our estimate for an increase of 30 per cent. in the labour charges incurred at present at Firozabad in order to allow for a substantial improvement in labour conditions. An improvement in the status and working conditions of labour may be expected to lead to a further increase in the rate of output and a consequent reduction in the cost per unit of glass. We have estimated a reduction in the proportion of breakages in the factory to 15 per cent. But we believe that if sufficient care is taken, the reduction may be still greater. The effect of a smaller percentage of breakage will be to bring down expenditure under every item except material and packing. It may also be pointed out that on soda ash and colouring chemicals, which represent the bulk of the cost of materials, there is at present a duty of 25 per cent. which represents nearly half a pie per dozen pairs of bangles. If, therefore, a reduction occurs in the general rate of import duty it will provide another substantial source of saving. On these facts there can be no doubt that the industry will eventually be able to dispense with assistance.

Measure and form of protection.

115. We have based our estimate of costs on an output of 400 tons of melted glass. The total production of the factory in 1930 was approximately 350 tons, of which 275 tons were melted in the factory and the rest was purchased in the form of block glass. The increase in output which we have estimated is so small in proportion to the output already attained that there should be little difficulty in working up to it immediately. We think, therefore, that in determining the measure of protection the estimated costs should be taken as the criterion. There is one factor, however, for which allowance should be made. We have pointed out in discussing blownware that there is a very considerable prejudice in the market against most kinds of Indian glassware. An examination of the prices realised by Indian bangle manufacturers shows a wide discrepancy between Indian and import prices. It is always diffi-

cult to determine how far prejudice of this kind is based on a demonstrable difference in quality and selling organisation and how far to other circumstances. It is, however, clear in the case of bangles manufactured at Firozabad that the proportions of soda and colouring materials used, on which quality depends to a large extent, are not the most suitable in comparison with imported bangles and this is part of the reason for the existing prejudice against them. We have also pointed out that no expenses are incurred at Firozabad on the provision of adequate selling arrangements and this is probably an additional reason for the low prices realised. A third factor is that the bangles are placed on the market unpacked while imported bangles are generally sold in attractive cardboard boxes. In our estimate of costs we have made due provision for all these factors including a higher consumption of coal in view of the smaller proportion of soda ash we have proposed and it is to be expected that to this extent Indian prices will show an improvement. The additions we have made to the Firozabad costs under these four heads may be summarised as follows:—

TABLE XLVI.

Per ton of glass.	Firozabad costs.	Estimated costs.
	Rs.	Rs.
Materials	88·57	172·70
Power and fuel	28·48	41·00
Selling expenses		15·00
Packing	5·71	140·62
	122·76	369·32

The extra expenditure for which provision is made in our estimate is Rs. 246·56 per ton of glass which is equivalent to 4·38 pies per dozen pairs of bangles. In the written replies submitted by the Glass and Bangles Industrial Association it was stated that the nett price realised for reshmi bangles was 5 annas per gross of pairs equivalent to 5 pies per dozen pairs. In their oral evidence, however, they stated that the price had since fallen by 6 pies per gross of pairs and may now be taken as 4½ pies per dozen pairs. It may be presumed that the fall in price has been due to the recent drop in the exchange value of the yen, and that 4½ pies may be regarded as the Indian realised price equivalent to the current import price. The current c.i.f. price of reshmi bangles is 8·12 pies which corresponds to a duty paid price of 12·18 pies. The difference between the Indian price and the import price is therefore 7·68 pies. If we deduct from this the additional provision made for materials, coal, selling expenses and packing, there is a balance of 3·30 pies which may be regarded as the nett disadvantage of the Indian industry in the market. Our estimate of the Indian fair selling price is 8·79 pies. Adding to this the disadvantage of the industry in the market we get a final price of 12·09 pies. The difference between this and the c.i.f. price is 3·97 pies which is approximately 50 per

cent. of the c.i.f. price. We recommend that protection for the bangle industry should be given in the form of an *ad valorem* duty of 50 per cent. A specific duty is clearly inapplicable in the case of bangles which are imported in a large variety of sizes and classes differing widely in value.

Economies resulting from the use of recuperative furnaces.

116. We have assumed throughout this discussion that the manufacture of bangles will be based on the present type of direct fired pot furnace. It is generally recognised that a recuperative pot furnace in which fuel is applied in the form of gas and arrangements are made for pre-heating the air required to burn it, is more economical and yields glass of much better quality and appearance. We have, therefore, tried to estimate on the data available to us to what extent the Indian bangle industry may expect to benefit by the employment of recuperative furnaces. The principal advantage will consist in a reduction of fuel consumption. A seven pot direct fired furnace of the kind now in operation can be replaced by a six pot recuperative furnace, each pot with a capacity of 10 cwts., without substantially altering the layout of the factory. The coal consumption in operating the furnace on a reasonable computation will not exceed 15 tons a week or 800 tons a year. Assuming a working period of 10 months in the year and allowing for breakages of pots and other contingencies, the output of melted glass may be estimated at a little over 800 tons a year. If provision is made for the additional coal consumed in the pot arch and in the conversion of glass into finished bangles, the quantity of coal consumed per ton of melted glass over the whole production will not be more than 2 tons. We have estimated a consumption of 3 tons of coal in the case of a direct fired pot furnace. Taking the effective cost of a ton of coal at Firozabad at Rs. 13-8, this figure will represent the saving in coal per ton of glass. In the case of the direct fired furnace we have assumed Rs. 3 per ton of glass as credit realised on account of the sale of cinders. As no cinders will be available for sale from a recuperative furnace, the nett saving on coal may be estimated at Rs. 10-8 per ton of glass. The total output which we have assumed for a direct fired furnace is 400 tons which will be exactly doubled if a recuperative furnace is substituted. The cost under 'Supervision' and 'Miscellaneous' will on this account be reduced by about Rs. 3·50. We have allowed a cost of Rs. 3·24 per ton of glass for crucibles in a direct fired furnace. We do not think that the cost of crucibles per ton of glass in a recuperative furnace will exceed Re. 1. The average life of a crucible is much longer in a recuperative furnace. More frequent fillings are possible and the crucibles have a larger capacity. Under "Repairs and Maintenance", including depreciation, we have allowed Rs. 6·28 in the case of a direct fired furnace. The heavier outlay required for a recuperative furnace will increase the charges under this head. We estimate the cost of building and erecting a recuperative six pot furnace at Rs. 30,000 and of a pot arch at Rs. 10,000. Taking depreciation on the furnace at 15 per cent. and on the pot arch at 10 per cent. and assuming an output of 800

tons of glass, the depreciation per ton of glass works out at Rs. 6·87. Allowing for occasional renewal of refractory materials, the total charges under depreciation and current repairs may be taken at Rs. 7·50 per ton of glass. Profit and interest will also be higher. We estimated a total capital expenditure, including working capital of Rs. 21,000 for a factory working with a direct fired pot furnace. The corresponding capital expenditure for a factory equipped with a recuperative pot furnace will be approximately Rs. 60,000. Profit at 10 per cent. on this with an output of 800 tons will work out at Rs. 7·50 per ton of glass. The result of these calculations may be summarised as follows:—

TABLE XLVII.

	Per ton of glass.	
	Direct fired.	Recuperative.
	Rs.	Rs.
Power and fuel	41·00	30·50
Supervision and miscellaneous	10·50	7·00
Crucibles	3·24	1·00
Depreciation and repairs	6·28	7·50
Profit and interest	5·25	7·50
TOTAL	66·27	53·50

The nett advantage on expenditure is thus about Rs. 12·75 per ton of glass or Rs. 10,000 on the whole output in a recuperative furnace.

Effect of recuperative furnaces in improving quality and appearance of glass.

117. The effect of recuperative pot furnaces in improving the quality and appearance of the glass is, however, of much greater importance to the bangle industry than the reduction in works expenditure. The durability of glass is affected to a large extent by the proportion of soda contained in it. A high proportion of soda renders the glass more brittle and considerably diminishes its durability. Bangle factories in India use an excessive proportion of soda in their compositions. This is necessitated partly by considerations of fuel economy but mainly by the limitations imposed by a direct fired furnace. The melting efficiency of a direct fired furnace is relatively low and the proportions in which the various raw materials are mixed have, therefore, to be adjusted to the low efficiency of the furnace. Since a large proportion of soda has the effect of considerably lowering the melting point of the batch, manufacturers find it convenient to make softer glass in direct fired furnaces. We have no doubt that the prejudice which exists in the market against Indian made bangles is partially explained by the fact that the glass is less durable and breaks more

readily. In the case of plain bangles the question of durability, perhaps, is not so important as in the case of decorated bangles of the more expensive varieties. The high prices at which these are sold make it essential that the glass should be stronger and more durable. Unless there is a decided improvement in the durability of the glass, the Indian bangle industry will not be in a position to capture the market for superior fancy bangles. It is, therefore, important that the furnaces operated by Indian bangle makers should have sufficient heating capacity to melt glass suitable for bangles of high quality. But it is not merely in improving the durability of glass but also in improving its appearance that a recuperative pot furnace will be found useful. Glass made in open pots in a direct fired furnace tends to be dirty and spotted. A recuperative furnace working on gas which is a cleaner fuel than coal produces glass of better appearance, suitable for the production of superior classes of bangles. The improvement in the quality and appearance of bangles which the replacement of the existing direct fired furnaces may be expected to bring about, will go a long way in removing the disadvantage against which Indian bangles have at present to contend in the marekt. In estimating the measure of protection we have assumed a nett disadvantage of 3·30 pies per dozen pairs. Every reduction of a pie in this disadvantage will increase the earnings of the manufacturer by about Rs. 55 per ton of glass. This represents in a factory with an output of 800 tons a total increase in the aggregate receipts of Rs. 45,000 which is more than equivalent to the cost of a recuperative furnace and pot arch. We have little doubt that for the further development and success of the bangle industry it is essential that manufacturers should direct their attention to the adoption of improved and more up-to-date furnaces.

Duty on bangles to be applied to false beads and pearls.

118. Bangles are at present subject to a revenue duty of 50 per cent. *ad valorem*. The same duty is applicable also to beads and false pearls. If our recommendation to impose a protective duty of 50 per cent. on bangles is accepted, we propose that the duty should be applied also to beads and false pearls. The articles are essentially similar in character and process of manufacture and there is no reason why Indian manufacturers of bangles should not undertake also the manufacture of beads and false pearls. As far as we are aware, there is at present only one factory in India which manufactures beads and false pearls. The factory is situated at Bombay and apparently depends on block glass imported from Japan for its principal material. Bombay is disadvantageously situated in respect of sand and coal and the cost of manufacture will therefore be higher than in other parts of India. We consider that if protection is granted, bangle factories will find it profitable to manufacture beads and false pearls from glass made locally. There is at present a substantial import in this line of glassware amounting to over Rs. 30 lakhs in 1929-30 and over Rs. 15 lakhs in 1930-31. If a protective duty is levied, it will provide a new outlet of considerable dimensions for the Indian glass industry.

(4) *General Recommendations.*

Summary of proposals

119. The proposals for protective duties embodied in this Chapter may be summarised as follows:—

(i) Sheet and Plate glass including figured and ribbed glass—Rs. 4 per 100 sq. ft. or 25 per cent. *ad valorem* whichever is higher.

(ii) Bangles, beads and false pearls—50 per cent. *ad valorem.*

(iii) Glass and glassware of the kinds specified below—50 per cent. *ad valorem.*

(a) *Containers other than those containing merchandise packed according to ordinary trade usage*—bottles and phials of all descriptions including soda and other aerated water bottles; jars of all kinds including stoppered jars.

(b) *Illuminating ware*—chimneys; globes; shades; chandeliers; domes; lamps wholly or partly made of glass.

(c) *Table and domestic ware*—Tumblers and jugs; dishes; bowls; plates; decanters; stands; vases; wine glasses; ink stands; paper weights; ash trays; pepper, salt and vinegar bottles.

(d) *Miscellaneous*—Tiles—roofing and floor.*

Burden on the consumer.

120. The duties which we have proposed represent in many cases a considerable addition to the cost of glassware used in India. The extra burden involved in our proposals is not, however, so excessive as to constitute a valid objection to the grant of protection. We are satisfied that in the great majority of cases it is not heavier than the burden which may normally be expected from the application of protective proposals. In the case of sheet and plate glass, the quantities used for ordinary building purposes in India are so small that the additional cost in individual cases will be hardly perceptible. If we assume that in an ordinary residential building of the kind occupied by an average middle class family, about 500 square feet of sheet glass are used, the total duty payable will be Rs. 20. The duty payable at the current rate is Rs. 7½, so that the additional burden in respect of the whole building will be not more than Rs. 12½. The glass used in public buildings and by railways is largely plate glass or superior polished glass on which under our proposals there will be hardly any increase in duty. Bangles, beads and false pearls are at present charged a duty of 50 per cent. and our proposal, therefore, involves no increase as far as these articles are concerned. Even if we adopt for the purpose of comparison the duty in force before the introduction of the recent surcharges, the addition in the duty payable on ordinary kinds of bangles will not exceed 2 pies per dozen pairs. In the case of an article which is used for ornamental

* Item (iii) (d) would necessitate the insertion of the words "Other than glass" after 'tiles' in Article 103 of the Statutory Tariff Schedule.

and decorative purposes, this cannot be regarded as excessive. As regards other kinds of glassware, the position may be illustrated by the following typical cases:—

	Approximate increase in duty.
(1) Ordinary sized Dietz lantern globe	4 annas per dozen globes.
(2) Ordinary sized Glass Jar (3 lb.) .	1¼ anna per jar.
(3) Ordinary sized Tumbler . .	5 annas per dozen tumblers.
(4) Pint bottle	¼ anna per bottle.
(5) Aerated water bottles—	
(a) Codd's pattern (10 oz.)	¾ anna per bottle.
(b) Crown cork pattern (7 to 10 oz.)	½ anna per bottle.

We do not consider that the increase in duty in these cases will inflict any special hardship. Some of the articles included above such as aerated water bottles and jars, on which the duty appears to be higher, possess considerable durability as compared with other glass containers. Soda water bottles particularly of Codd's pattern can be refilled many times over and consequently the actual duty payable on them by the purchaser of aerated waters is a good deal lower than the figures above would indicate.

Period of Protection

121. Elsewhere in this Report we have pointed out the principal directions in which the Indian glass industry stands in need of improvement and the means by which such improvement may be effected. An extensive reorganisation of the industry as regards methods of production, equipment and financial resources is required. Sufficient time must be afforded to the industry to make full use of the protection granted, so that the reorganisation which we have in view may be completed. We think that in the circumstances of the glass industry a longer period of protection is required than the Board has generally recommended in other cases. We propose that the protective duties should remain in force for a period of ten years. A shorter period than ten years will be insufficient to create the necessary confidence on the part of the investor in the future of the glass industry.

CHAPTER IV.

Supplementary Proposals.

(1) *Organization of Research and Training.*

Defects in present methods of working

122. In chapter I we have given a brief account of the processes employed in Indian glass factories at present. We have there stated that we consider that the Indian industry has made considerable progress in certain important respects. At the same time it is evident that there are several matters in respect of which the present practice in many factories is susceptible of improvement. So far as the selection and treatment of raw materials are concerned, we have made certain suggestions in Chapter II, and as regards methods of manufacture we consider that the following points should commend themselves to manufacturers for their immediate attention.

Furnaces

123. In their furnace design and practice most of the Indian glass factories are capable of considerable improvement. It is now universally accepted that gas-fired furnaces are more efficient in every way than direct fired furnaces. For the manufacture of lampware, pressed ware and bottles tank furnaces would undoubtedly be more economical than pot furnaces. For the manufacture of bangles, where glass of various colours is required, pot furnaces will have to be retained, but the direct fired furnaces should be replaced by gas-fired recuperative furnaces. The Japanese type of pot furnace generally employed in Indian factories is smaller in size compared with the size of the pots than the English type of furnace, which consequently had a greater reserve of heat in its structure; it allowed of the pots being set further from the firebox, and the flues carried the flames round the front of the pots and maintained them at a more regular temperature. The greater reserve of heat in the English furnace permitted broken pots to be removed and new pots set without reducing the temperature of the furnace so low that the working of glass had to be stopped and other pots were cracked and broken. There is at present only one works in India in which pots are set while the furnace continues in operation, in all the other works the common practice is to run the furnace till about half the pots are broken when it is put out and another started, the sound pots remaining in the furnace being sacrificed. This happens in most cases about once a month when certain repairs are always necessary. The constant putting out and reheating imposes excessive wear and tear upon the structure of the furnace and limits its working life to six months, after which period it needs rebuilding. In consequence of the need for constant repairs and rebuilding the structure of these furnaces is far less substantial

than that of the English furnace, which usually worked for seven to ten years without major repairs, and they lose more heat by radiation. Further, the setting of pots close to the fire box causes excessive heat at the back of the pot, while the arrangement of flues between the pots does not produce sufficient heat in front of them. Consequently the pots are subjected to excessive strain, and their average life in most of the works is less than a month, while nowhere do they last for three months. The rectangular pot furnace does not attain any higher degree of efficiency than those of circular shape. The gas-fired pot furnace is of an old continental type which is neither designed nor operated in the best manner; and it does not operate for more than one or two years before major repairs become necessary. The importance of introducing better furnace design and practice cannot be overestimated. More efficient furnaces will enable the manufacturers to improve their glass compositions, reduce the proportion of soda ash—which as we have seen in the case of bangles particularly is far too high—and at the same time with less cost turn out better, more durable glass.

Manipulation and annealing.

124. The practice which we have noticed of gathering the glass in two portions is generally uneconomical though it may be advantageous under special conditions. Improved furnaces and glass compositions would render this unnecessary. The separate manufacture and remelting of block glass has nothing to recommend it economically and should be given up. The conditions in which some of the labour (especially boy labour) is employed particularly in bangle factories are intolerable and a study should be made of the possibility of introducing mass production methods in such operations as separating the bangles from the spiral, welding the ends of the circles and the various forms of decoration. There is scope also for investigation into possible extensions of this branch of the industry such as the manufacture of the more expensive kinds of bangles from glass tubing and the manufacture of beads and false pearls. The desirability of introducing automatic or semi-automatic machinery for the manufacture of pressed and blownwares needs investigation. It should be possible to replace the 'mould boy' by some mechanical device. It is not healthy for a boy to work cramped in a confined space, close to the furnace and almost in contact with the hot mould and hot glass. The appearance of the glass would be improved by using a carbonaceous paste in the mould instead of wet paper and much waste could be avoided by paying more attention to the design of the moulds. The introduction of cutting wheels, cracking off machines or cutting flames would render unnecessary any over-blow between one globe or chimney and another and would also save the wastage involved by the present methods of separating the articles. The manufacture of bottles by hand processes should be given up except in special cases. Hand made bottles must always vary in capacity, weight, thickness and length of neck, and in one factory at least these natural handicaps are increased by the blower manipulating

the glass without a stationary marver. Generally, the failure of the management to insist on a reasonable standard of production leads to excessive variation in the articles manufactured. With a bottle making machine, provided proper attention is paid to the composition of the glass batch and to the temperature of the furnace, the opportunity for such variations is reduced to a minimum. Even when equipped with modern lehrs some factories prefer to use their old kilns and we have seen more than one annealing lehr standing idle while kilns are being used. Lehrs consume less fuel and anneal the glass much more rapidly than kilns, the use of which is only justified for heavy and expensive ware. The use of kilns for annealing bottles, jars and lampware is exceedingly wasteful and should be discontinued.

Protection ineffective without research and training.

125. Many of these suggestions for the improvement of the present practice in the factories point to the need for an organised study of the various problems which the industry presents. It is generally recognised that even in its simplest forms the glass industry is highly technical and requires for its development a high degree of skill and of scientific and mechanical equipment. The difficulties experienced by Indian manufacturers of glass are to be attributed largely to the lack of adequate provision for the investigation of scientific problems connected with the industry and for the training of managers possessing the requisite knowledge of technology and modern methods of manufacture. We are convinced that unless any tariff assistance granted to the industry is supplemented by suitable organisation for training and research, the progress of the industry will be slow and incommensurate with the burden which our proposals will place on the country. The Indian Industrial Commission (1916-18) in their report expressed the view that tariffs "will prove ineffective unless they give rise to scientific enquiry and expert treatment of the many problems involved". Similar views have been expressed by other industrial experts who have since enquired into the subject. Our examination of the Indian glass industry has led us to the same conclusion. While we hold that the severe competition to which the Indian industry is exposed renders protection essential, we consider that protection by itself will not secure the further development and ultimate success of the industry. Assistance of a more direct kind is indispensable during the period of protection, and unless this is given, protection will fail to achieve its object. We desire, therefore, to state explicitly at the outset that the suggestions which are put forward in this chapter must be regarded as part and parcel of our proposals for assisting the glass industry.

Main lines of investigation.

126. There is hardly a feature of the glass industry in India which does not call for the immediate provision of systematic, scientific investigation. Although sand is available in sufficient quantities in India, we have already indicated our view that in order to enable the manufacturers to produce glass of high

quality it is essential that arrangements should be made for further investigation of the chemical and physical properties of available sands and for improving their quality by washing, grading, etc., and ensuring constancy of quality in sands supplied to manufacturers. Similarly, the determination of the best glass compositions for different kinds of glassware from the point of view of durability, appearance and economy requires closer examination. A subject which is of great importance to manufacturers is the supply of suitable refractory materials. A number of manufacturers are already making their own refractory blocks and pots but a good deal is still imported. An investigation of Indian clays with reference to the special requirements of glass manufacturers and closer co-ordination between them and Indian producers of fire-bricks and clay will lead to useful results. The high ash content of Indian coal renders it desirable that the possibility of the employment of mechanical producers or other means of overcoming the disabilities of Indian coal should be determined. Suitable provision should also be made for advising manufacturers regarding the type and size of furnace required and the methods of operating it, the use of control devices and the employment of annealing lehrs. A question of vital importance to the industry is the introduction of automatic and semi-automatic machinery in almost all processes of manufacture. Machinery however should not be installed except on considered recommendation, particular regard being paid to the low cost of Indian labour. Lastly, a great deal of attention should be given to remedying the excessive wastage in the factories with which is bound up the whole question of the internal organisation of the works.

Training of Personnel.

127. These problems which affect the Indian glass industry as a whole should be taken up for immediate investigation and research. But along with investigation and research, facilities should also be provided for training Indians for the posts of managers and scientific assistants in glass factories. The training of skilled workers for such processes as glass blowing and spiralling in bangle manufacture may be left to the factories themselves. A great deal of useful work in training skilled operators has already been accomplished by glass factories in India originally with the assistance of workmen imported from Japan and to some extent from European countries and latterly under the guidance of Indian workers. The Paisa Fund Glass Works at Talegaon near Poona have been primarily instrumental in providing a trained body of glass blowers for factories in many parts of India which enabled them to cope with the rapid increase in production which occurred during the war. It is now the practice in many of the larger factories to admit boys under a definite system of apprenticeship for training in glass blowing and other skilled processes; and the results achieved so far must on the whole be regarded as satisfactory. The Indian workman shews a high degree of aptitude for skilled manipulation of the kind required in a glass factory and from our observation of the men at work in the factories we visited, we are

satisfied that, under qualified and efficient supervision, a high standard of workmanship and output may be expected. The urgent need of Indian factories at present is the provision of well qualified men for supervision and control. It is to this aspect of the question that manufacturers should now devote their attention and in respect of which their need for assistance is most urgent. We consider that if a scheme is instituted for the investigation of the scientific problems involved in glass making in India, it should be regarded as an essential feature of the scheme that training should be provided under it for those who desire to qualify themselves for responsible positions in glass factories. The scheme should be so arranged that the staff engaged in connection with it should combine the duties of research and training and thus provide the nucleus for a possible school of glass technology.

Location at Harcourt Butler Technological Institute.

128. If our proposal to organise an institution for research and training in glass technology is accepted, we consider that it should be located at the Harcourt Butler Technological Institute at Cawnpore. The United Provinces contain a larger number of glass factories than any other province, including the biggest and best equipped factories in India. Firozabad in the same province is practically the home of the glass bangle industry. The best sand deposits in India are to be found in the United Provinces from which the bulk of the Indian factories draw their supplies. Cawnpore is within convenient distance of the principal factories in the province and is therefore advantageously situated for undertaking experimental work in close touch with actual working conditions in factories. The Harcourt Butler Technological Institute is already the centre of teaching and research in certain branches of industrial technology in the United Provinces. In it is also located the department of sugar technology recently started by the Imperial Council of Agricultural Research. We have further been informed that proposals are under consideration for converting the present oil section of the Institute into an all-India Department financed by a Central Oil Cess Committee. The Institute thus provides a suitable centre for research in scientific problems connected with industries. We have ascertained that sufficient accommodation is available in it for the proposed department of glass technology and that facilities already exist for experimental work on many questions connected with the manufacture of glass. The Institute is under the control of the Department of Industries in the United Provinces and was started with the object of providing facilities for industrial research and training in the province. But we understand that the Government of the United Provinces would be prepared to open an all-India section for glass technology at the Institute if the necessary funds were granted by the Government of India. We think that in many respects the Institute affords possibilities of developing ultimately into a centre of industrial investigation and education for the whole of India. Educationally as well as financially there is a great deal to be said for concentrating such facilities as are available in

this respect in one institution as far as circumstances permit. Most modern industries present a common scientific background which renders it possible and indeed desirable, that the resources available for the investigation of industrial problems should be pooled and that there should be a large measure of concerted work and organisation. We consider it therefore of the highest importance that every effort should be made to utilise the Harcourt Butler Technological Institute in connection with our proposals for the development of the glass industry.

Outline of scheme for research and training.

129. In the course of our tour to the United Provinces during the present enquiry, we took the opportunity of discussing these proposals with the Director of Industries and with the Principal of the Harcourt Butler Technological Institute. We also received subsequently a valuable memorandum from each of these officers regarding the lines on which research and instruction in glass technology may best be undertaken. Although in arriving at our conclusions we have been greatly assisted by their ready and willing co-operation, we desire to make it plain that for the actual proposals which are set out herein, we hold ourselves entirely responsible. We propose that the staff should consist of one glass technologist who will be the head of the department assisted by one senior assistant and three or more junior assistants. Provision should be made also for studentships for graduate research workers and for laboratory assistants together with the necessary office staff. Much of the apparatus required for the work is already in the Institute but some provision would be required for special equipment at the beginning and also an annual provision for materials and equipment and for the travelling expenses of the staff. We estimate that the total annual expenditure will not exceed a lakh of rupees. The future of the scheme will depend largely on the personnel of the staff whose work in the initial period will determine the ultimate success or failure of the scheme. This applies particularly to the glass technologist who will be required not merely to carry out the current duties of the department but to lay down at the beginning the main lines of work and to organise the department. He should in our opinion be a man who combines the qualifications of a first class research worker in glass technology with adequate experience of both the practical and commercial aspects of the glass industry. He should at the same time possess sufficient personality and tact to enlist the sympathy and co-operation of glass manufacturers and to work in harmony with the management of the Technological Institute and with his colleagues. We have pitched our estimate of the qualifications required for the head of the department at a high level because we are assured that a scheme of this kind would be entirely ineffective unless it was adequately manned. It would probably be impossible at the beginning to secure the services of an Indian having the necessary qualifications. In that case we suggest that a suitable man should be recruited from abroad for a limited period on the distinct understanding

that at the end of the period his place would be taken by his Indian senior assistant. We therefore consider that the senior assistant should be chosen with special care. He should be a person of high scientific attainments preferably with industrial experience and possessing the personal qualifications required for administering the department when he is placed in charge of it. The other assistants should be chosen from among young Indian graduates who have distinguished themselves in physics, chemistry or engineering and have shown an aptitude for research.

Relations with manufacturers of glass.

130. While the glass technologist would be in independent charge of his department and entirely responsible for its work, he should, as far as his external relations are concerned, be subject to the control of the Principal of the Harcourt Butler Technological Institute. We consider it desirable that arrangements should be made from the beginning for associating with the work of the department representatives of the glass industry and of the public generally. This should take the form in the initial stages of a small advisory committee consisting of representatives of the industry and of the Central Legislature. We look forward to a time when the usefulness of the department will have received sufficient recognition at the hands of glass manufacturers to induce them to take over its support and management and employ it as an organ of the Indian Glass Manufacturers' Association. The Indian glass industry can do a great deal towards improving its position both commercially and technically by better organisation. Every glass manufacturer whom we examined deplored the present lack of organisation in the industry and its effects on the level of Indian prices and the prevailing standards of work. We consider that the department of glass technology, when it comes into being, should regard it as part of its duties to assist Indian glass manufacturers to organise themselves more effectively both in the matter of sales and in the enforcement of standards of quality. These are recognised functions of industrial associations, and we hope that the association of Indian manufacturers with the department of glass technology will help the evolution of a corporate spirit in the industry and a sense of pride in its standards and achievements.

Grant by Central Government.

131. We have estimated the annual expenditure at a figure not exceeding a lakh of rupees. We propose that an annual contribution at this rate should be made by the Government of India to the Government of the United Provinces for the maintenance of the department of Glass Technology at the Harcourt Butler Institute. It should be laid down as a condition of the grant that the services of the staff should be available for glass manufacturers in other provinces also and that the glass technologist and his assistant should be permitted by actual visits and in other ways to maintain contact with the glass industry in different parts of India. It is obviously impossible to frame even an approximate estimate of the revenue likely to be derived from the protective

duties which we have proposed. But a rough indication of the position is afforded by the calculations set forth in the Appendix. These figures show that the liability of the Government of India in respect of our scheme for research and training will be amply covered by the increased revenue from the protective duties on glass.

Devolution Rules examined.

132. Although the development of industries is strictly a provincial subject, grants for this purpose by the Government of India are permitted by the Devolution Rules under certain conditions. Item 20 in Part I of Schedule I to the Devolution Rules includes among Central subjects "Development of Industries in cases where such development by central authority is declared by order of the Governor General in Council, made after consultation with the local Government or local Governments concerned, expedient in the public interest". Otherwise the Development of Industries is a provincial subject (Item 25 in Part II of Schedule I). On the assumption that it is not permissible to incur expenditure from central revenues on provincial subjects, our proposal that the Government of India should make a contribution for the organisation of research and training in glass technology implies the publication by the Government of India of a declaration that the development of the glass industry by central authority is expedient in the public interest. Such a declaration was made regarding the steel rail and railway waggon industries in Notification No. 39-T, dated 14th June, 1924, and published at page 485 of the Gazette of India, Part I. To admit a case for protection necessarily implies conviction that the development of the industry is expedient in the public interest. We are satisfied that the glass industry has made good its claim for protection; it follows that the development of the industry is expedient in the public interest; and since the additional revenues from the protective duties which we propose will place the Central Government in funds, it is on the Central Government that the industry will have to depend for the contribution necessary to finance the other measures recommended for its development.

Need for supplementing protective duties.

133. In concluding our discussion of these proposals, we desire to emphasise the view expressed earlier in this chapter that no permanent development of the glass industry in India will be achieved unless provision is made immediately for research and training on the lines we have suggested, and that assistance by means of tariffs alone may prove in the long run entirely fruitless. We have observed with growing apprehension that when proposals are made by the Tariff Board to supplement protective duties with more constructive methods of assistance, no tangible efforts appear to be made to give effect to such proposals. If this practice is continued, the policy of protection may yield few results of any value as regards the development of the industries and may in the end prove little more than a convenient means of raising additional revenues. In our recent report on the Paper industry, we pointed

out how the rejection of the Board's proposal to grant direct assistance to the industry resulted in unduly delaying the development of bamboo pulp. We made a similar proposal in our report regarding the Sugar industry as "a condition precedent" to the grant of protection, on which also no action has apparently been taken so far. Protective duties divorced from the constructive measures proposed in connection with them may represent an immediate gain to public revenues but they constitute in reality an expensive and possibly wasteful form of assistance to industries. We are constrained to express our views strongly on this question because we feel that unless public attention is directed to it, important national interests may be jeopardised. In no case which has come under enquiry by the Tariff Board has this question been more forcibly brought to our notice than that of the glass industry. For this reason we trust that the proposals put forward in this chapter will not merely receive sympathetic consideration but will be implemented without delay.

(2) Establishment of Foreign Concerns.

Establishment of foreign concerns not inconsistent with the policy of protection.

134. It was suggested by some of the manufacturers who gave evidence before us that protection for the Indian industry would prove ineffective unless steps were taken to prevent foreign manufactures from establishing factories in India behind the tariff wall and thereby taking advantage of the protective duty. That the establishment of factories in India by foreign manufacturers is in itself inconsistent with the policy of protection is an assumption which finds no support in the Fiscal Commission's report nor in any declarations of policy by the Legislature or the Government. On the other hand, in most countries which have adopted a system of protective tariffs, it is recognised as an incidental advantage of protection that it encourages the establishment of factories in the country by foreign manufacturers who previously had supplied the market with goods produced in their own country. The increased employment of indigenous labour and materials and the stimulus to competition provided by the erection of such factories are generally accepted as beneficial results of a policy of protection.

Conditions to be observed by foreign concerns.

135. There are two considerations however which qualify and to some extent limit the application of this principle. The first is that while the establishment of factories by foreign manufacturers is undoubtedly of potential advantage to the country, there are certain conditions to which they must conform in order that their activities may be brought into line with the declared aims of protection. As far as India is concerned, these conditions are clearly specified in paragraph 292 of the Fiscal Commission's Report dealing with Indianisation and allied matters and have been accepted by the Government and the Legislature as essential conditions to the grant of protection. If foreign

factories are established subject to these conditions, there can be no objection to their carrying on manufacture in India under a protective tariff. But it is obviously necessary that the Government should see that new concerns which may come into existence during the period of protection conform with these conditions. The concerns now engaged in the glass industry in India already satisfy these conditions.

Danger of monopolistic developments.

136. The second consideration is one to which little attention has so far been given in public declarations of policy; but its importance in situations which may conceivably arise under a policy of protection cannot be doubted. Even in cases where foreign concerns established in India satisfy the conditions laid down in paragraph 292 of the Fiscal Commission's Report, the resources at the disposal of such concerns may be so great as to enable them to establish a practical monopoly in the industry concerned. With the increasing tendency to combination and 'rationalisation' the danger of monopolistic concerns being established in protected industries is one to be reckoned with. To the extent that these concerns comply with the conditions regarding Indianisation, no objection can be raised against them on the ground that their existence will militate against the employment of Indian labour and the participation of Indians in the capital, management and direction of the industry. The danger in the case of such undertakings is that the interests of the consumer with which the policy of protection is equally concerned may be ignored. The central idea of the policy of discriminating protection is that the development of the industry will eventually result in the establishment of efficient methods of production based on internal competition so that the consumer "may in the end obtain the goods as cheaply as if he were to import them without a duty". It is obvious that monopolistic combinations may defeat this end even where they arise among Indian manufacturers. But where the monopoly arises from the action of foreign manufacturers who have been induced by a protective tariff to establish business in India, the danger is doubly great because not merely may the interests of the consumer be neglected but when protection is removed the industry itself may be transferred to a foreign domicile. When protection is granted for a long period at a rate which covers full depreciation, it is not improbable that at the end of the period of protection capital will have been written down to such an extent as to enable the industry to be transferred from India with little or no capital loss. The danger is not any the less serious because the first effects of the creation of a monopoly are generally in the direction of a lowering of prices. But in this matter it is necessary to take long views and to examine every development in the light of its ultimate effects. Should any tendency to the creation of a monopoly, particularly in connection with a foreign concern, arise in a protected industry, it is the duty of the Government to institute prompt enquiry and take effective action on the lines proposed by the Fiscal Commission in paragraph 86 of its Report.

137. We have thought it necessary to draw attention to this question because we believe that in the conditions of the glass industry there is some ground for the apprehensions which are widely felt by Indian manufacturers on this subject. As we have already pointed out, the total production of the Indian glass industry at present probably does not exceed 20,000 tons a year and the bulk of the manufacture is carried on by small or medium sized concerns with relatively small resources. Under these conditions the possibility of the industry being captured by powerful foreign interests, if adequate protection is granted, cannot be entirely ignored. In the case of one important branch of the glass industry, namely, the manufacture of bangles, India provides probably the sole market so that protection for the Indian industry may offer a distinct stimulus for the establishment of foreign concerns in India. The particular methods which may be found most suitable for dealing with the problem must necessarily depend on the circumstances of each case. But we think that if protection is granted to the glass industry, the Government should declare in advance their intention to adopt such methods for meeting the situation as may be found necessary from time to time. Such a declaration will, we believe, have a deterrent effect sufficient to minimise the need for subsequent action.

Action necessary in the case of the glass industry.

J. MATTHAI,
President.

FAZAL IBRAHIM RAHIMTOOLA,
Member.

G. T. BOAG,
Member.

March 17, 1932.

APPENDIX.

Estimate of revenue likely to be yielded by the protective duties on glass.

In the following calculations it is assumed that:—

(1) if there were no protection, the normal annual value of imports would be the average of the two years 1929-30 and 1930-31.

(2) if there were no protection, the normal duties applicable would be 30 per cent. on bangles, beads and false pearls and 15 per cent. on every other kind of glassware.

(3) the effect of the protective duties would be to reduce the imports by 50 per cent. at the end of the period of protection except in the case of "sheet and plate" and "other glassware" which include unprotected articles.

(4) the price of imported glassware would remain constant during the period of protection.

(5) there would be no growth of consumption during the period of protection.

TABLE I.

Normal amount of revenue without protection.

	Normal imports at average of 1929-30 and 1930-31.	Amount of revenue at normal rates.
	Rs. lakhs.	Rs. lakhs.
Bangles, beads and false pearls	90·72	27·22 @ 30 per cent.
Bottles and phials	34·71	5·21 @ 15 per cent.
Funnels, globes and glass parts of lamps	10·66	2·50 @ 15 per cent.
Sheet and plate	27·42	4·11 @ 15 per cent
Tableware	11·36	1·70 @ 15 per cent
Other glassware	26·04	3·91 @ 15 per cent
TOTAL	206·91	44·65

TABLE II.

Amount of Revenue from protective duties at the end of the period of protection.

	Value.	Amount of Revenue at protective duties.	
	Rs. lakhs.	Rs. lakhs.	
Bangles, beads and false pearls @ 50 per cent. of normal	45·36	22·68	
Bottles and phials @ 50 per cent. of normal	17·35	8·67	
Funnels, globes and glass parts of lamps @ 50 per cent. of normal	8·33	4·16	
Sheet and plate—			
(Plate at ⅓rd of total) . .	9·14 plate	2·28	@ 25 per cent.
(Sheet at ⅔rds reduced by 50 per cent.)	9·14 sheet	6·40	@ approximately 70 per cent.
Tableware @ 50 per cent. of normal .	5·68	2·84	
Other glassware @ ⅓rd of normal .	17·36	3·47	@ average duty of 20 per cent.
TOTAL .	112·36	50·50	

N.B.—'Scientific Glassware' is excluded from both Tables. It is wholly unprotected and its inclusion would therefore not affect the result of the calculations. No account is taken of glass tiles which are now shown in the Trade Returns under 'Building Materials'. The quantity of imports is however small and will not materially affect the result.

MGIPC—L—60STB—21-5-32—750.